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TEACHERS IN TECHNICAL COLLEGES AND SCHOOLS

IN an article in *Nature* of June 22, 1946, the salary scales of teachers in technical schools in Great Britain were criticized in the following terms: "the very comprehensive character of the Burnham scales for technical teachers militates against their effectiveness in the realm of higher technology. The scales for technical teachers have, for reasons which it is not easy to understand, been closely tied to those applicable to teachers in primary and secondary schools. For the large majority of teachers in technical institutions they are in fact identical with them, and only in the provision of separate scales for heads of departments in technical colleges and the introduction of a senior assistant scale for a limited number of technical teachers do they differ from the school salaries. The scales are designed to cover the whole range of further education from the teachers in a small country technical institute to the lecturer in a major technical college, the junior lecturer in which, however advanced and important his work, may be on the same salary scale as the teacher in the smallest institution."

These words are no less applicable to the recently announced proposals of the Burnham Technical Committee which will, if accepted by the constituent bodies, become operative on April 1, 1948. The proposals made by the Technical Committee follow closely those put forward by the main Committee, which is responsible for the recommendations in respect of teachers in primary and secondary schools. They include, for example, the same basic scale, the same proposals regarding the 'London Area', the same provision for graduates, and the same intention to abolish the merger clause. Again, in the provision of posts of special responsibility, local education authorities are left to determine the number of such posts (between 20 per cent and 27½ per cent of the number of full-time teachers other than principals) to whom the Burnham Technical Report applies (which is, admittedly, an improvement on the present position of between 19 per cent and 21 per cent); but the financial limits are, as in the main report, between £50 and £150 per annum for men, and between £40 and £140 per annum for women.

More satisfactory, however, are the proposed scales for senior assistants and heads of departments. In these a real attempt has been made to recognize the validity of the claim—made in the McNair Report on the Training of Teachers—that a senior lecturer in a technical college is responsible for work not dissimilar from that of a lecturer in a university, and that the head of a large department in a technical college has responsibilities for organisation and research comparable with those of a university professor. The proposed salary scale for senior assistants is £700–£25–£800 per annum for men, and £560–£20–£640 per annum for women. For heads of departments, it is proposed that there should be four fixed grades with a maximum in the fourth grade of £1,250 per annum for men and £1,000 per annum for women, and a flexible fifth grade which

will allow local education authorities to fix, in agreement with the Minister of Education, a salary beyond these limits for a departmental head in a large college.

Even if these scales are agreed, much must depend on the policy adopted by local education authorities in appointing senior assistants and in grading departmental heads. But the difficulties which local education authorities will encounter—and the variations which must inevitably occur between the practice in one area and another—are not likely to be lessened by the failure of the Burnham Technical Committee to establish salary scales for principals. Since failure to do so in 1945 is an important factor affecting adversely the recruitment of highly qualified men and women possessing suitable training and experience to the staffs of major technical colleges, it is certainly to be hoped that the Minister of Education will interpret generously the provision which empowers him to report to the Committee in 1951 on the review of principals' salaries which local education authorities are required to make in the light of the other recommendations in the report. Since it is not unreasonable to suppose that the recommendations of the Percy Committee regarding the National Council of Technology and the regional advisory councils will, within the next three years, be fully implemented, the time may well be opportune in 1951 for the Minister to consider drastic changes in the administration and finances of technical education in Great Britain.

CHEMICAL BASIS OF MUSCLE CONTRACTION

Chemistry of Muscular Contraction

By A. Szent-Györgyi. Pp. vi+150. (New York: Academic Press, Inc.; London: H. K. Lewis and Co., Ltd., 1947.) 4.50 dollars.

THIS book is largely a summary of the work of the Szeged school carried out just before or during the war years, and is not designed for the consideration of past or contemporary studies on muscle and muscle proteins. It is, indeed, an intensely individual book, representing a rather novel and daring approach to the problem of physiological contraction. This, no doubt, explains the widespread interest which Prof. Szent-Györgyi has aroused, and among the background of polemical discussion which such interest has invoked, the reviewer must attempt an impartial judgment which is not shocked into scientific conservatism by novelty, but is based solely upon objective consideration of experimental data. Unfortunately, a critique along these lines is not wholly possible: some results are personally communicated; others are derived from data not yet accessible; others, still, do not conform with more recent experiments as described in a 'stop-press' section (Part IV). In these circumstances, it seems most profitable to discuss only the more important features which are especially relevant to the problem of muscle biochemistry, leaving the interpolated section on "The Continuum Theory" (Part III) for other comment.

The outstanding contribution is the discovery that the muscle fibril contains an, as yet, ill-defined protein termed 'actin' which interacts with myosin to give an actomyosin complex. Actomyosin is influenced by traces of adenosinetriphosphate in two different ways, according to the ionic strength of the medium. In 0·5 *M* potassium chloride, the complex exists as a thixotropic gel which is broken up into its component molecules in presence of adenosinetriphosphate; in 0·05 *M* potassium chloride, however, the gel on addition of adenosinetriphosphate exhibits an intense synæresis (termed by Prof. Szent-Györgyi 'contraction'), giving a dense precipitate of actomyosin containing 50 per cent of its weight of protein, whereas myosin precipitates ordinarily contain only 2–4 per cent of protein. It is this latter effect which forms the basis of various speculations on muscle contraction.

It is clear that the actin–myosin interaction is an unusual one, and more recent work in Britain and Denmark has emphasized this fact in the finding that the sulphydryl groups of the myosin partner play an essential part. Obviously, the urgent need, before attempting to relate the actin–myosin–adenosinetriphosphate interrelationships to muscle contraction, is to resolve the mechanism of this synæresis. Does it involve the aggregation of micelles and the squeezing-out of intermicellar water as in the formation of the fibrin clot? Or does it involve an intramolecular saturation of side-chain linkages? There are no really adequate data to decide these facts, and to transpose this system to muscle itself as the basis of the contractile process is not to offer an explanation of how muscle contracts; the clockwork of the model is missing. There might be some virtue in the model if it conformed with accepted concepts of the structure of the fibril; but in the assumption that the contracting elements have a spiral structure, it opposes the evidence of the electron microscope and X-ray diffraction. Moreover, the experiments relating to the energetics of muscle contraction, even if valid, are not specific to the theories advanced and reveal nothing of the molecular mechanism of contraction.

In all that concerns the properties of proteins there are serious misconceptions. The whole treatment of the binding of ions by myosin is both confused and confusing, and governed by physico-chemical inventions which not only conflict with each other but also with experimental fact and with physico-chemical theory. It is assumed, for example, that when a neutral salt is added to a negatively charged myosin precipitate, cations are adsorbed in such a way that the protein becomes isoelectric. The extension of this adsorptive process to the point where the protein dissolves lands the author into great difficulties, as a reading of the section on p. 114 adequately shows. Other claims, that myosin is not a globulin, and that it is genuinely crystalline, are quite inadmissible.

To the biochemist, the enzyme sections present a bewildering display of new facts and conclusions which must certainly invite both interest and criticism. No final judgment can be attempted, since much of the experimental detail is not available. There is a tendency, however, to attribute an astonishing variety of findings to an astonishingly simple system. It is said that myosin–adenosinetriphosphatase, acting in conjunction with 'protein II', effects first a breakdown to adenosinediphosphate; phosphate is then transferred from the pyro- to the amino-group to give a new adenosinediphosphate, which is then simultaneously de-

phosphorylated and deaminated. In absence of protein II, myosin–adenosinetriphosphatase is stated to produce not only adenosinediphosphate but also an adenosine-tri- and diphosphate dinucleotide. Obviously, if these reactions occur, a rather complex enzyme system is present. Again, the metal activation of adenosinetriphosphatase gives rise to a complex picture which is more easily accommodated by assuming the presence of other enzymes, and these effects have, in fact, been discussed in contemporaneous studies. There are strong suggestions that some of the reactions induced by proteins I and II are due to Kalckar's myokinase: protein I plus myosin plus adenosinediphosphate produce a syneresis of actomyosin, due to the biosynthesis of adenosinetriphosphate, presumably by the agency of myokinase. Because the partially purified protein I contains a chromoprotein (fluorochrome), it is tacitly assumed that this is the enzyme concerned in the above reaction. These several points serve to implement the contention that the findings must be supported in due course by the most exhaustive experimental evidence. In this connexion, it is necessary to stress that to prove the existence of an isomeric adenosinediphosphate or of a new dinucleotide is a most difficult task; one recalls inevitably the controversies on the structure of adenosinetriphosphate itself, and the careful studies on the nucleotide of heart muscle, claimed by some to be a diadenosine pentaphosphate, by others a mixture of adenosine-tri- and diphosphate, and in any event a problem still unresolved.

These are not the only aspects of the enzymic material which even in the most favourable light must remain contentious; equally so are the conception of 'protins', the implication that succinic dehydrogenase is an actomyosin, and that adenosinetriphosphatase is a property of 'contracted' actomyosin. For the unwary reader, several errors are apparent: the ordinate of Fig. 16; the salt concentration, at the top of p. 28; and the fibre dimensions, p. 32.

Although objective scientific criticism must be unfavourable, and although it is difficult to separate the gems of fact from the trinkets of fancy, so deftly are they intermingled, the book possesses many virtues. It is eminently readable, imaginative, stimulating, sometimes humorous, and reflects Prof. Szent-Györgyi's own delightful and unique personality. Though it may very profitably be read by all critical people, it should not be recommended to uncritical and over-receptive students. In the last analysis, the hard core of the book, the myosin–actin–adenosinetriphosphate interrelationship, holds great possibilities for the future understanding of muscle biochemistry and biophysics.

KENNETH BAILEY

PEONIES

A Study of the Genus Pæonia

By F. C. Stern. Pp. viii + 156 + 15 plates. (London: Royal Horticultural Society, 1946.) 63*s*.

ALL who are interested in the genus *Pæonia*, whether botanists or gardeners, will welcome Colonel Stern's critical review, and the Royal Horticultural Society is to be congratulated in producing such an imposing volume. The author's skill as a horticulturist has earned him a high reputation in the acclimatization of plants, and this talent has been directed during the last twenty-eight years to the cultivation of wild species of peony. With his study of living material, examination of dried specimens in the principal herbaria, and survey of the literature bearing on the genus *Pæonia*, the author is well equipped to present an authoritative account. He freely acknowledges the assistance which he has received from professional botanists in the elucidation of taxonomic and nomenclatural problems.

Chapter 1 contains a conspectus of the genus in which the species are grouped in three sections: *Moutan*—an Asiatic group of four species with woody stems and with prominent development of the disk at the base of the carpels; *Onæpia*—consisting of two herbaceous species, native in western North America, in which the disk is prominently lobed; *Pæon*—a widespread section of thirty-seven species which are herbaceous with no conspicuous lobing of the disk and which extend from south-western Europe to Japan. An interesting feature in the section *Pæon* is the occurrence of eight pairs in which the plants are practically identical, except that in one member of each pair the carpels are glabrous while in the other they are densely pubescent. There is no geographical segregation in each pair, and Colonel Stern regards the distinction as only of varietal status. Four new subsections are defined and typified, and artificial keys are given to the sections, subsections, species and varieties; and it may be mentioned that the keys, tested on fresh and preserved material, have proved a satisfactory guide to the identity of the plants. The morphology of the genus is discussed, and an assessment is made of the characters of systematic value.

In the final section of the first chapter there is an account of the cytology of the genus, and a list is given of the chromosome numbers of the different species as determined at the John Innes Horticultural Institution. It is possible to distinguish cytologically the New World species from those of the Old World, but otherwise the size and morphology of the chromosomes is very uniform. In certain closely allied species, difficult to distinguish on their external morphology, chromosome numbers have been accepted as taxonomic criteria, and in the case of *Pæonia* this policy may be justified. Many systematists, however, will disapprove of the recognition of species based solely on differences in chromosome number and, should similar examples be multiplied, it may be necessary to devise a separate nomenclature for cytological categories.

Chapter 2 contains a summary of the distinguishing characters of peony species and a detailed account of their geographical distribution. The sections are reviewed individually and the distribution of the various groups is shown very clearly on beautifully delineated maps. In discussing the geographical range of the members of the genus, Colonel Stern suggests that the cytology of the species indicates relationships which, when considered in association with the present distribution and comparatively recent climatic history, give a clue to their evolutionary spread. His discussion is certainly suggestive, and his speculations, though applying to a relatively small group of plants, will be carefully weighed by students of plant geography.

The genus is holarctic, with two species in western North America and the others with a wide range across the Old World. The closely related North American species are diploid, and in their botanical

characters are most akin to the shrubby Chinese species. In Europe and the outlier in North Africa, groups of allied species and varieties occupy the same geographical area, and in each of these groups one species is diploid with a much more restricted range than the others, which are tetraploid. Excluding the representatives in the Caucasus and Asia Minor, the Asiatic groups of species and varieties (which contain what are probably the most primitive species, including herbaceous members with more than one flower to a stem and also shrubby species) are all diploid, with the exception of one group which has a diploid species in Japan and a connected tetraploid on the Chinese mainland. Why in Asia and America do the diploid species so greatly outnumber the tetraploids, and why do tetraploids predominate in Europe? Colonel Stern suggests that events during and after the glacial period may have determined the cytological constitution of species and so influenced their distributional potential.

In Europe, by the southerly displacement of the vegetational zones during glacial times, the existing diploid peonies were forced into the Mediterranean basin and on to some of the Mediterranean islands. It is supposed that as a result of this geographical disturbance tetraploid species were derived from the diploids and, when conditions ameliorated, the more vigorous and better adapted tetraploids spread rapidly northwards and also crossed into north Africa. This hypothesis may explain why, in the European groups of related species occurring in the same areas, the diploid species have a much more restricted range than the derivative tetraploids. The diploid peonies of eastern Asia, it is surmised, are ancient relicts, which survived *in situ* during the glacial epoch and thus avoided genetic disturbance leading to tetraploidy. Cytological investigation of certain related genera and species may assist in the interpretation of their geographical range; but the genetic factor, while obviously important, must not be emphasized to the exclusion of other considerations. It seems significant that the genera in the British flora notorious for the numbers of 'critical' or endemic species have all been disrupted to some extent in the glacial periods, and the complications in these groups may be due to genetic disturbance resulting from climatic upheavals.

The individual species and varieties are fully described and discussed in Chapter 3; a full synonymy is given and specimens examined are cited. Unfortunately, scant mention is made of the collections, including types, preserved in the British Museum, and this disregard has resulted occasionally in an inadequate appreciation of the geographical range. For example, *P. Delavayi*, according to the monograph, is confined to Yunnan; but there is a specimen (*Kingdon Ward* 12214) from the Po-Yigrong region of south-east Tibet which was named by the author and yet is omitted from his enumeration. A more serious oversight has led to the treatment of Pallas's *P. hybrida* as a species *non satis nota*. Type-material is, however, preserved in the British Museum and, by Colonel Stern's classification, is referable to *P. anomala* var. *intermedia*.

One would have expected, in a book bearing the *imprimatur* of the Royal Horticultural Society, that some attempt would be made to deal with the hosts of named hybrids and forms which are more generally cultivated than the wild species; but for information on these, gardeners must still refer to nurserymen's catalogues. Apart from these criticisms, the enumeration reveals a careful and well-considered survey of the genus.

A fully documented chronological bibliography of the genus occupies Chapter 4, and a history of the species in cultivation with practical advice on their culture concludes the volume. The list of peony species and synonyms forming Appendix 1 gives no references to the text and could have been conveniently included in the general index.

"A Study of the Genus Paeonia" is a credit to the author, artists, printers and publishers, and sets a high standard in botanical and horticultural writing. The book is a splendid and timely token of British scholarship and craftsmanship, and the freshness of the beautiful coloured plates calls for a special word of praise. Perhaps it is not too much to hope that the Society will sponsor further volumes in this style; they could scarcely fail to appeal to botanists and gardeners alike.

GEORGE TAYLOR

TECHNICAL MATHEMATICS

Applied Mathematics for Engineers and Physicists By Dr. Louis A. Pipes. Pp. xiii+618. (New York and London: McGraw-Hill Book Co., Inc., 1946.) 27*s*. 6*d*.

THIS text is an excellent addition to the increasing number of books which seek to acquaint the physicist and engineer with the modern methods of mathematics as applied to technical problems.

The subject-matter is based on lectures given by the author at the Graduate School of Engineering, Harvard University, and covers both basic mathematics and relevant applications to physical and engineering problems such as conduction of heat and vibrations of beams.

Though general in scope, the book should be valuable to the specialist as a work of reference which can be consulted to ascertain the power and field of application of particular methods such as the use of matrices or of the operational calculus. Having chosen a method promising for his particular problem, the research worker can then proceed, if necessary, to a specialist book, references to which are given by Dr. Pipes at the end of each chapter.

On a point of detail, it is noted that two lists of Laplace transforms are given in widely separated chapters, involving considerable duplication, the first list being in excellent tabular form, whereas the second is given in the less easily consulted form of consecutive equations without tabular division. In future editions it is suggested that these lists could be amalgamated into one table at the end of the book for ease of reference. Apart from this minor criticism, the text appears well written and arranged and includes problems for the reader to test his skill or the power of a method.

Though primarily designed for the graduate, this text could well take a place on the bookshelf of the brighter undergraduate, since the subject-matter is unusually wide in range, covering, for example, both a first introduction to complex numbers in the second chapter and the analysis of non-linear oscillatory systems in the final chapter.

In general, this book can be recommended to all engineers and physicists interested in improving the range and power of the mathematical tools at their command.

E. N. Fox

A Practical Course in Agricultural Chemistry

For Senior Students of Agriculture, Dairying, Horticulture and Poultry Husbandry. By Frank Knowles and Dr. J. Elphin Watkin. Second edition. Pp. xi+216. (London: Macmillan and Co., Ltd., 1947.) 12*s.* 6*d.* net.

LABORATORY handbooks of agricultural chemistry for students are not numerous, and the second edition of Knowles and Watkin's useful practical course is especially welcome at present, when laboratories and teachers are so hard pressed to cope with their swollen classes.

This book adequately covers the subject, and one feels that it has been written by men of experience who are used to helping students and are well acquainted with their difficulties in laboratory manipulations. While not claiming to be a textbook, this manual includes sufficient background to explain the import of the exercises described.

Since the first edition, in 1936, new commodities, concepts and methods have come into use, and the authors have revised and enlarged their text accordingly. The section on soil has been improved by additional exercises on moisture relationships, nitrogen economy and cation-exchange aspects of the soil, while the recent prominence of triple superphosphate, agricultural salt and sewage sludge is recognized in the fertilizer section. There are new exercises on vitamin C and on blood, and the section dealing with dairy products has been enriched by amplification of the pages on the freezing point of milk and on dairy detergents. The detection of mineral deficiencies in plants by leaf analysis breaks new ground here, and the concluding section on fungicides and insecticides now includes exercises on the newer products such as D.D.T. and 'Gammexane'.

These various additions have expanded the work by twenty-six pages, but its clear type and prominent headings make it easy to use and read.

Microfotografia e Macrofotografia

Principi e applicazioni della technica microfotografia al laboratorio di recherche scientifiche e industriali. Per Prof. Edgardo Baldi. Pp. xii + 349 (18 plates). (Milano: Ulrico Hoepli, 1946.) 900 lire.

THE Italian title of this book may well prove misleading to English readers. Its subject is in the main photomicrography (not microphotography), with a relatively small section dealing with such matters as still photography and document reproduction.

The author is a biologist, and it is therefore not surprising to find that the physics of the microscope is treated from an elementary point of view. Nevertheless the first two chapters cover all that is essential to an understanding of the role of illumination and the formation of images. Brief mention is made of the phase-contrast technique, which is now enjoying such a deserved vogue. The Köhler system of illumination is given justifiable emphasis, and detailed instructions are provided for adjusting the illuminating system. The second chapter concludes with descriptions of the well-known types of condensers and vertical illuminators—these latter including that of Lieberkühn and the Leitz 'Ultropak'.

Chapters 3 and 4 deal with both ordinary and special types of equipment, including objectives and eyepieces. Chapter 5 treats the question of macrophotography, and Chapter 6 that of filters. Chapter 7 gives a general outline of the procedure for taking a photomicrograph, while the final chapter concerns itself with photomicrography in the infra-red and ultra-violet regions respectively.

There are a number of elementary errors in this book. The camera head indicated in Fig. 133, for example, is shown with a semi-reflecting prism of a type which would ensure that no image could possibly be formed on the photographic plate. A great deal of care is called for in the preparation and publication of a handbook of this type, care which in this case one feels has occasionally been lacking. The book contains little information not already available elsewhere, and is consequently not likely to be in great demand outside Italian-speaking countries.

H. H. HOPKINS

Atlas of Histopathology of the Skin

By Prof. G. H. Percival, Prof. A. Murray Drennan and T. C. Dodds. Pp. viii + 494. (Edinburgh: E. and S. Livingstone, Ltd., 1947.) 75*s.* net.

APART from the comprehensive and justly famous "Pathology of the Skin" of Macleod and Muende, British medical literature is lacking in works on this subject. This new book is smaller in scope than the former, the authors confining themselves, not too rigidly, to the commoner skin diseases and restricting description and discussion to an adequate minimum. Details of pathological technique are entirely omitted.

The 376 illustrations are all photomicrographs in colour, and the reproductions, with few exceptions, are most exact at all magnifications. Those dermatologists who have, in the past, decried photographs as less revealing than drawings will do well to study these pictures.

The book is intended to be a companion to textbooks of dermatology and a guide-reference for dermatologists and pathologists. In these aims the authors have been most successful. Special praise is due to Mr. T. C. Dodds, the technician and photographer, and to the printers for the excellence of this publication. It will be welcomed by everyone in the field of dermatology and may stimulate the laggards in this neglected field of investigation.

An Insect Book for the Pocket

By Edmund Sandars. Pp. 350 (36 plates). (London: Oxford University Press, 1946.) 10*s.* 6*d.* net.

THE objects of this little book are to aid its users in identifying and learning something about the larger insects in the British Isles. Owing to the number of species—more than twenty thousand—the size criterion is adopted in order to keep the subject within reasonable compass. Only species exceeding half an inch in body-length, or one inch in wing-span, are dealt with, and, in this way, the number of families to be described is reduced from more than three hundred to about 130. Groups consisting of very small insects only come in for mention if they are of special interest or of economic importance. It is surprising how well this very arbitrary standard has worked out in this manual. It is an accurate and well-written little book. The coloured plates and text-figures are adequate for their purpose and there is a useful list of works for consultation. A pleasing feature running through the pages is the indication (in brackets) of the meanings of the generic and specific names referred to: also the price of the work is very reasonable under present-day conditions.

A. D. I.

PENICILLIN AND OTHER ANTIBIOTICS

THE concentrated research effort on antibiotic substances during the last six or seven years has provided results and new materials of the greatest interest to medical science, to chemistry and to general biology. The relatively recent nature of this work, most of which was undertaken as a direct consequence of the clinical success of penicillin, has obscured to a great extent the fact that work on antibiotics had been carried on since the middle of the nineteenth century, in the fields both of medical microbiology and of plant pathology. The organisers of the symposium on "Penicillin and other Antibiotics" at the British Association meeting at Dundee, by bringing together Sections B (Chemistry), I (Physiology) and K (Botany), sought to arrange their programme so that these various aspects were touched upon.

Sir Alexander Fleming gave a general introduction to the symposium. Defining an antibiotic as "a substance, produced by a living body, which is toxic to micro-organisms", he pointed out that neither the effect nor the word antibiotic is new. Antagonism between bacterial colonies or between mould colonies and bacteria is a commonplace of clinical laboratories, well known for years before the chance contamination which led to the discovery of the effect of penicillin. Even in the nineteenth century an antibiotic preparation from *Pseudomonas pyocyanea* known as pyocyanase was used therapeutically, though with little success. All the chemical antiseptics in use at the time of his work on penicillin were more toxic to leucocytes than they were to bacteria, and penicillin was the first substance encountered which destroyed bacteria without having any appreciable effect on human leucocytes. Penicillin retains prominence in its low toxicity, and this is largely responsible for its great clinical success.

Sir Alexander then briefly surveyed the steps leading from his original observations to the large-scale production of pure crystalline penicillin. In the course of this he commented on the highly valuable free interchange of results between academic workers and industrial firms both in Great Britain and the United States, which was in large measure responsible for the rapid progress made during war-time, and regretted that now, in conditions of peace, such co-operation appeared to be much less easily attained. He concluded by remarking that though penicillin has its disadvantages, such as instability in aqueous solution and a definitely limited range of organisms against which it is clinically effective, it is nevertheless not going to be easy to find a drug superior to penicillin in its own field.

Dr. E. Chain dealt with the chemical structure and biological activity of four types of antibiotic. His first type was the polypeptide group comprising gramicidin, tyrocidine and gramicidin *S*. Each of these substances is a simple polypeptide, the proportions of the constituent amino-acids being known in each case. A point of chemical and biological interest is that each of these contains amino-acids of the 'unnatural' *d*-configuration. Gramicidin *S* is chemically the simplest of these substances. The basic unit is a pentapeptide containing the following arrangement of amino-acids:

α-*l*-valyl-*l*-ornithyl-*l*-leucyl-*d*-phenylalanyl-*l*-prolyl.

The gramicidin *S* molecule is probably built up of two of these pentapeptides, linked in a cyclic structure. These substances are both bacteriostatic and bactericidal, active mainly against Gram-positive bacteria. They are not efficient chemotherapeutic agents owing to too great a toxicity. Their high toxicity represents an interesting biochemical problem, as there is no obvious reason why a dekapeptide of the above constitution containing simple amino-acids, each of which is known to be non-toxic, should show such marked pharmacological properties. Subtilin, bacitracin and the colicines, also polypeptide antibiotics of bacterial origin, are remarkable for their high specificity. Further knowledge of their chemical structure would be of great interest, as it might lead to an understanding of the relation between the structural arrangement of the polypeptide molecule and its specific biological activity.

Helvolic acid is probably a polycyclic compound related to the triterpenes. It is highly active against Gram-positive bacteria, relatively non-toxic to mice and antibacterially active in the body. Nevertheless, it is not an effective chemotherapeutic agent in mice. Analysis of its mode of action has shown that it is purely bacteriostatic, having virtually no killing effect. The mouse has no natural resistance against *Streptococcus*, and hence helvolic acid, as it does not kill organisms, is ineffective in eradicating a streptococcal infection.

Dr. Chain next considered the only two antibiotics which have shown any practical possibility in medicine, namely, streptomycin and penicillin. Streptomycin is bacteriostatic to some organisms and bactericidal to others. It is of highest efficacy as a chemotherapeutic agent in diseases caused by those organisms which it is able to kill, such as *Hæmophilus influenzæ* and *Pasteurella tularensis*. Clinically, successes have been obtained in the streptomycin treatment of some cases of miliary tuberculosis and tubercular meningitis, but it is yet too early to evaluate finally its role as a chemotherapeutic agent in clinical tuberculosis. Streptomycin possesses certain disadvantages. Like other antibacterial bases, it is most active above *p*H 7, its activity decreasing with decreasing *p*H, and so has relatively low activity at the *p*H of many body tissues. In addition, it is not devoid of toxic effects. More important is the fact that many organisms (including *Mycobacterium tuberculosis*) develop resistance very rapidly, frequently in one or two subcultures only. However, in spite of these objections, streptomycin shows considerable promise as a chemotherapeutic agent in several diseases where penicillin is ineffective.

In dealing with penicillin, Dr. Chain pointed out the chemical novelty of the β-lactam ring in the penicillin molecule. This is responsible both for the instability that caused the initial difficulties in isolation, and for the extraordinary molecular rearrangements that can be produced by relatively mild chemical treatments. From the medical point of view, penicillin still remains unique among all antibacterial substances in that it is non-toxic, not antagonized by tissue constituents, is independent of inoculum-size and has a definite killing effect on rapidly dividing cells. With the exception of *Staphylococcus*, bacteria do not readily develop penicillin resistance.

Here the discussion was continued by Dr. J. A. Elvidge, who described work on the chemical synthesis of penicillin, with particular reference to the more recent work carried out at the Imperial College of

Science and Technology, London. Indications of successful syntheses of traces of penicillin were obtained in Oxford and in the United States in 1944, and the isolation of minute quantities of penicillin was reported by du Vigneaud in 1946. The surprising fact is that these syntheses were achieved by methods based on a mistaken view of the structure of the penicillin molecule. For a considerable time chemical evidence was unable to decide whether the now well-known thiazolidine-oxazolone or β-lactam structure was correct; a decision in favour of the latter was based on data provided by X-ray crystallography and infra-red absorption spectra. The syntheses mentioned above were based on the supposed thiazolidine-oxazolone structure; that of du Vigneaud being by the condensation of 4-methoxymethylene-2-benzyl oxazolone with penicillamine. However, only traces of penicillin have been produced by this method, which appears to be of little practical value, and consequently at the Imperial College routes of a more promising aspect were sought and eventually found in methods involving thiazoline intermediates. The present state of this work was then described in some detail by Dr. Elvidge, and it was evident that further results of great interest are to be expected.

A really workable synthesis of penicillins and structurally related compounds is highly desirable. Pentenyl-, benzyl-, ρ-hydroxybenzyl- and heptylpenicillin have been found naturally. Even among this relatively small number of penicillins, quite marked differences in antibacterial activity, solubility and stability are found. Particularly in therapeutic effectiveness do ρ-hydroxybenzyl- and heptylpenicillins differ. Hence it is possible that even more effective penicillins could exist, with more desirable physical properties—perhaps enhanced chemical stability and activity against a greater or different range of micro-organisms. Chemical methods of synthesis would make feasible the preparation of many modifications and derivatives and enable the many attractive possibilities to be investigated.

Up to this point, the discussion had centred around antibacterial antibiotics of medical interest. Another approach was made by Dr. P. W. Brian, who spoke on fungistatic antibiotics, considering the matter particularly from the point of view of the plant pathologist. A number of most important plant diseases are caused by soil-inhabiting fungi which attack the roots, vascular systems and base of the host plants. It was found early in the investigation of these diseases that if the host plant were grown in sterile soil inoculated with the pathogenic fungus, the symptoms observed were usually far more severe than if a normal untreated soil were used. It was widely deduced from this observation that some of the normal saprophytic members of the soil microflora are 'antagonistic' to the pathogen, and many such antagonistic organisms were in due course isolated.

Later workers found that in many cases treatment of an infected soil with a culture fluid on which the antagonistic organism had grown was as effective as inoculating the soil with the organism itself. A particularly well worked out research on these lines was that of Weindling (1931–41) on the role of the fungus *Trichoderma viride* in antagonizing the damping-off disease of *Citrus* seedlings caused by the fungus *Rhizoctonia solani*. He found that the disease could be much reduced by acidifying the soil. This was effective, not by directly reducing the vigour of the *Rhizoctonia*, but by encouraging the growth of an antagonistic fungus, namely, *Trichoderma*. He also found that the antagonistic *Trichoderma* could kill *Rhizoctonia* at a distance in an agar medium and that a liquid culture medium on which *Trichoderma* had grown was highly toxic to *Rhizoctonia* hyphæ. He carried this research a stage further and in 1936 isolated in pure form from such toxic culture filtrates the now well-known antibiotic gliotoxin.

Since then, many examples of the production by fungi of substances toxic to other fungi have been discovered, as well as production of such substances by other types of micro-organisms. Some of them are general poisons, toxic also to bacteria and other organisms, examples being gliotoxin, patulin, aspergillic acid, citrinin, gladiolic acid and penicillic acid. Others, such as viridin and glutinosin, are specifically toxic to fungi only. Other substances again, unlike those just mentioned, which have a definite killing effect like most synthetic fungicides, reduce the rate of fungal growth by causing marked abnormality in development; an example is griseofulvin ('curling-factor'). [See also p. 574.]

Dr. Brian concluded by suggesting that antibiotics should receive more attention from the point of view of soil processes and soil-borne plant diseases than they have so far done, and that in this field many of those antibiotics which have received little attention from the medical microbiologists, owing to such undesirable properties as toxicity, may nevertheless be of the greatest significance.

The remaining two papers aimed at relating the production of antibiotics by micro-organisms to their general biological and biochemical background, Dr. J. Ramsbottom dealing with the biological, and Dr. S. E. Michael with the biochemical, aspect.

Dr. Ramsbottom confined himself mainly to consideration of production of antibiotics by fungi, but the conclusions he reached may be regarded as equally valid for all antibiotic-producing organisms. The production of antibiotic substances is part of the general problem of the relation between organisms. Organisms do not live in pure culture in Nature, but in the presence of many other kinds of organisms. All sorts of relationship may be possible between different species in a mixed population, from antibiosis to symbiosis. He recalled the original definition of antibiosis by Vuillemin, in 1889, who considered that all types of association could be placed on a scale ranging from the pure parasitism of the blight fungus (*Phytophthora infestans*) on the potato (a phenomenon he called 'antibiose'), where only one partner in the association gained any advantage, the other suffering a corresponding disadvantage, to those cases where, by mutual benefits, both partners gained, such as the relationship between fungus and alga in the lichen thallus ('symbiose'). Marshall Ward expounded similar views at the Dover meeting of the British Association in 1899. More precise definitions of the terms 'antibiosis' and 'antibiotic' than the current ones are needed, or we shall have the same confused thinking that has been associated with symbiosis, which was originally thought best exemplified by parasitism.

More recent research has shown that many of the symbiotic types of association have a chemical basis. For example, it has been found that the well-known observation that infection of orchid seeds with a mycorrhizal fungus is necessary before germination can take place is due to a need of the embryo for aneurin, which is synthesized by the fungus. Similarly, it has been found that on a vitamin-free medium

neither the fungus *Mucor ramannianus* nor the yeast *Rhodotorula rubra* will grow at all. If mixed inocula are used, both organisms grow perfectly. The reason for this surprising result is that the *Mucor* is unable to synthesize the pyrimidine moiety of aneurin but is able to synthesize the thiazole moiety, whereas *Rhodotorula* is able to synthesize the pyrimidine but not the thiazole. Thus the two in association act in a complementary manner and growth becomes possible.

In view of many such instances of a chemical background for symbiotic relations, it seems possible that the production of antibiotic substances may have some significance in explaining 'antibiotic relations', whether of the nature of the parasitism of fungi on higher plants or antagonism between fungi and other micro-organisms. Various plant juices have proved to be 'antibiotic'. Fragments of an orchid tuber suppress the growth of its mycorrhizal fungus; this may be related to the fact that the fungus is always restricted to definite areas of the growing root. These facts lead to the tentative suggestion that antibiosis may on occasion be an essential ingredient of symbiosis. Dr. Ramsbottom quoted the antagonism between *Trichoderma viride* and other fungi, with its possible connexion with gliotoxin and viridin production; the antagonism demonstrated by Van Luijk in 1939 between *Penicillium expansum* and *Pythium* spp. and its possible connexion with patulin production; the relation between the wilt-fungus *Fusarium lycopersici* and the tomato plant, in connexion with production of the wilt-producing polypeptide lycomarasmin. Caution is necessary in interpreting these facts; in Dr. Ramsbottom's words "the balance [between organisms] is probably controlled *to some extent* by the ability of some organisms to produce antibiotics, though it would be teleological to suppose that they have a purposeful origin".

Dr. S. E. Michael wound up the discussion by considering the chemical structure of mould antibiotics in relation to the general metabolic chemistry of fungi. Systematic study of the metabolism of lower fungi by Raistrick and his colleagues has shown that moulds of one or of several species yield products which are closely related variants of a particular type of structure. Examples that can be quoted are the toluquinone series (fumigatin and spinulosin); the anthraquinone series of mould pigments (helminthosporin, cynodontin, ω-hydroxyemodin, catenarin and erythroglaucin); the tetronic acid series (carolic acid, dehydrocarolic acid, ascorbic acid and penicillic acid). These few examples—far from complete—show the remarkable variety of compounds found as metabolic products of moulds, and the tendency for these products to be variants of a smaller number of basic patterns of molecular structure.

A number of well-known antibiotics fall into one or other of these general classes. Those of the tetronic acid series are particularly interesting. Tetronic acid belongs to the important and widely distributed class of unsaturated γ-lactones. This unsaturated lactone structure has been found in a number of antibiotic substances, and it is of considerable interest to see how variations on this basic molecular structure affect biological activity. The whole carolic acid series and ascorbic acid are devoid of antibiotic activity. On the other hand, the antibiotics penicillic acid, patulin, vulpinic acid and protoanemonin (extracted from higher plants) are all unsaturated γ-lactones. If their structure is considered, it appears that activity is associated with an unsaturated lactone ring carrying at least one ethylenic or carbonyl radical outside the ring, and also in some cases a methoxy or other ether group attached to the unsaturated carbon atom of the ring. Where the unsaturated radical outside the ring is missing (dihydropenicillic acid, α-β-angelicalactone), or where the ether group has been replaced by a hydroxy-group (the carolic acid series), antibiotic activity is reduced or absent.

These examples show that many mould antibiotics can be recognized as variants or derivatives of structurally known metabolic products. Others, on the other hand, such as penicillin, appear at our present state of knowledge to possess chemical structures not hitherto recognized in natural products.

The wide field covered by this discussion makes it difficult for either a chemist or a biologist to appreciate the significance of all the points brought forward. Nevertheless, it is hoped that this short review will help to indicate the varied types of interest in antibiotics now being shown in different branches of science. It should also be explained that, in order to give a logical presentation of the material, the order in which the various contributions were given has been altered.

P. W. Brian

CRACK DETECTION

A TWO-DAY symposium on methods of crack detection was held under the auspices of the Industrial Radiology Group of the Institute of Physics during July 18–19 in the lecture theatre of the Electric Lamp Manufacturers' Association, Savoy Hill, London.

The chairman, Mr. W. J. Wiltshire, explained that the group has recently included lectures comparing other methods of non-destructive testing with radiological methods, and the symposium was an instance of this extension of activity.

A short address was given by Dr. W. Betteridge, who explained the importance of cracks in both metallic and non-metallic components, the various means by which the main types of crack are formed, and the principal methods of detection. The latter he divided into three groups: the essentially visual methods, including the ways of making a crack more apparent, such as etching, dyeing, magnetic ink indication, etc., and radiography, the visual examination then being made on the film instead of on the actual component; the inferential methods such as the use of supersonics or of electrical resistivity, in which the presence of a crack is deduced from its disturbance of the normal lines of sound or current flow; and the mechanical methods, including proof loading, pressure testing, damping, etc.

Mr. C. Croxson dealt in detail with the application of radiography to the detection of cracks. He said that not many years ago a high-grade component containing a crack would have been immediately condemned; but nowadays repairs by excision and welding under radiographic supervision are often satisfactorily performed. A discouraging factor is the difficulty of assessing the mechanical significance of a crack by correlating radiographic results with practical experience. Penumbral unsharpness, due either to a broad focus tube or a small target-specimen distance, is not very detrimental and, within limits, may even lead to increased sensitivity; but graininess in the film is a great handicap, and the use of the finest grained film is recommended. The sensitivity of radiographic methods is higher than generally sup-

posed, and cracks only a few ten-thousandths of an inch in width can be detected in steel plates up to half an inch in thickness if favourably oriented. The discernibility of a crack is related to the ratio of the width to the angle of inclination to the X-ray beam; but for shallow cracks, where the inclination does not noticeably change the appearance of the image, it depends on the cross-section of the crack. Mr. Croxson concluded with a number of illustrations of the application of radiography to the detection of cracks in castings, forgings and welds, and, in summarizing the usefulness of the method, said that, in his opinion, serious hot tears or cold cracks in castings could not escape detection by radiography, and the same applied to cracks in forgings provided a critical technique was used with an understanding of the probable location and direction of the cracks. In welds small cracks could escape detection, but these are usually of little practical significance.

Mr. P. Rowbotham surveyed the various visual, etching and magnetic methods of detection, and explained that for all these the best results could only be expected if the inspectors worked under optimum conditions of lighting. A trained inspector working under ideal conditions can achieve very high sensitivity. Magnifying lenses and low-power microscopes can be helpful, but the small field of view and the necessity for frequent refocusing are disadvantages. Their value is mainly in the assessment of a crack following its detection by a more sensitive method. Brief descriptions were given of several common methods of increasing the visibility of a crack, including etching, anodizing, the use of oil and chalk, fluorescent liquids, etc., all these depending on the absorption into the crack of a liquid which afterwards oozes out. Finally, the magnetic methods for ferromagnetic materials, in which the escape of flux at the crack is indicated by a detector fluid, were described. For all these methods the crack must break through the surface of the part, except that the magnetic method will reveal cracks which are only a small distance beneath the surface.

The use of electrical conductivity methods for non-magnetic metals was dealt with by Mr. A. M. Armour, who explained that while a crack will disturb the lines of current flow in a metal in the same way as the lines of magnetic force in a ferromagnetic material, the electrical method is much less sensitive than the magnetic method because of the lack of a sufficiently sensitive detector of the lines of current flow. Most success has been achieved by the use of scanning search coils coupled to an indicator to give a signal on passing the vicinity of a defect. The use of two balanced search coils symmetrically placed with respect to a primary coil has enabled relatively uniform material such as sheet or bar to be examined successfully; but the method fails when a complicated component is to be dealt with because of the disturbances introduced by changes of section. Success has also been obtained in the search for diametrical cracks in large light-alloy billets by rotating the billet in a magnetic field and causing the eddy currents produced to react on two opposed search coils. A direct-current potential drop method has also proved of value for the detection of laminations in sheet, lack of adhesion in bearing liners, etc.

Supersonic methods were described by Mr. D. O. Sproule. The shadow detection method, in which the effect of a defect on the transmitted primary beam is observed, was considered to be of low sensitivity compared with echo methods, and the method in which the reflected beam interferes with the frequency-modulated primary beam was also described as of less importance than the echo method using pulse excitation. In the latter case the primary beam consists of pulses of sound at a frequency of a few megacycles per second produced by an oscillating quartz crystal, and the reflected energy is picked up by a similar crystal in the intervals between the primary pulses. The depth of the defect is determined by the time interval between the primary and reflected pulses; but the character of the defect producing the echo is not readily determined, although, by frequency variation, defects of relatively large areas, such as cracks, can be differentiated from fine porosity. The application of the method to components of different shapes was described, and the sensitivity to such small defects as hair-line cracks in large steel billets was illustrated.

The last paper was by Mr. M. Baimler, who described the development of industrial radiology in Czechoslovakia. The general position is very similar to that in Great Britain; but the advantage of using a long anode tube, which radiates in all directions in one plane and thus enables a circle of a large number of components to be radiographed at a single exposure, was stressed; the tube-film distance of about 12 feet gives sharp definition, and the increased exposure time is more than compensated for by the number of components dealt with at one time. An ingenious screening stand for dealing with castings weighing up to about 3 cwt. was described.

In the discussion which followed, Mr. A. G. Warren made a plea for the use of the term ultrasonic to describe high-frequency sound, supersonic being used in connexion with speeds above that of sound. The need for a detector for electrical conductivity methods was met in the case of high-frequency currents by sparking across the crack, which was easily visible. He said that cracks at angles above 45° to the direction of the lines of force could easily be detected by the magnetic ink method if the flux density were high enough. Mr. Rowbotham agreed, but found it preferable to control the flux density so that the limit of sensitivity was at about 45°. Mr. Armour described a combined radiographic and magnetic method, the exposed and processed film forming the base on which the magnetic record is deposited by a special detector ink. Mr. H. Capper said that fatigue cracks are frequently missed by radiography, and complementary methods should always be applied. Permanent magnets are found useful for magnetic crack detection. Eddy current methods have been found by Mr. E. G. Stanford to be of value for checking consistency of products for dimensions, composition, temper, etc., and the changes introduced by such variables make crack detection ambiguous. Mr. D. J. Jones described the difficulty of finding longitudinal cracks in sealing wires for the lamp industry; visual examination at a magnification of 10–20 was found best. Mr. W. C. Heselwood had found the shadow ultrasonic method preferable to the potential drop method for the detection of laminations in steel plate. In answer to a question by Mr. A. Maskery on the possibility of using a single exploring head for ultrasonic work, Mr. Sproule described a method of using two balanced heads, one on a standard sample and the second exploring the test sample, defects then being indicated by a disturbance of the balance; but he thought that a single head generally gave less information than the separate transmitter and detector.

THE INTERNATIONAL UNION OF GEODESY AND GEOPHYSICS

By Dr. J. M. STAGG
General Secretary

LIKE all large families, the group of scientific unions with the International Council of Scientific Unions as foster mother has a wide range of interests: one of the elder members of the family, the International Union of Geodesy and Geophysics, is itself big enough and broad enough in outlook to find a place for sciences with superficially so little in common as geodesy and hydrology, seismology and oceanography, vulcanology and meteorology, terrestrial magnetism and atmospheric electricity. So the International Union of Geodesy and Geophysics is a real confederation of unions (or associations, as they are called in the Union), each more or less autonomous, having its own president, secretary and bureau, its own statutes and by-laws and its own procedure for dealing with the problems within its domain. In addition, there is a Commission on Continental and Oceanic Structure which has the status of an association, and, more recently formed, a primary Committee on the Social Value of the Earth Sciences to look after the broader economic, social and political implications of the Union's work. Most of the associations have a number of sections or committees specializing in various aspects of their fields of geophysics.

Though all these constituent organisations of the International Union of Geodesy and Geophysics meet at the time of the triennial general assembly of the Union, they also continue their scientific activities for the most part separately, and arrange their own meetings between assemblies as they choose. Little of this has been possible since the general assembly held in Washington in September, 1939; and yet, as the recently published report* shows, it is remarkable how quickly the Union has revived and put its house in order ready to renew its wide activities. There is little doubt that much of this quick recovery is due to the energetic and experienced work of the late general secretary, Brigadier H. St. J. L. Winterbotham. Even before the War had properly begun he had taken steps to safeguard the Union's funds and contrived to keep an emergency organisation running until the end of hostilities, although the president, Dr. Ir Cour, had died early in the War and contacts with other senior officers were very restricted. Some of the associations, on their side, continued their work in some measure throughout the War, supporting themselves on the annual subscriptions from their own and neighbouring countries.

As a sequel to a meeting of the Executive Committee of the Union, convened shortly after the end of hostilities, an extraordinary assembly was called in 1946 to put the Union on its post-war feet again. That assembly was held in Cambridge in 1946 and was attended by delegates from sixteen of the pre-war total of some thirty member countries. It made important decisions for the future of the Union, not the least being a radical change in the method of subscription by member countries and institutions. As with most other similar Unions, countries adhering to the International Union of Geodesy and Geophysics have paid (or tried to pay) an annual subscription determined by their population. This was manifestly unfair to countries like India and China, and had obvious results. A decision of last year's extraordinary assembly was designed to provide a remedy: in future each member country may itself choose any one of eight categories of membership, the only proviso being that the category selected has to be formally approved by the Union's council, on which every country has one representative. The category of membership determines the annual subscription to be paid, and the voting power in Council or General Assembly in discussions involving finance.

The details of this innovation have been embodied in new statutes and by-laws which were adopted by the Cambridge assembly and have since been approved by all adhering countries. These new statutes and an account of the other decisions made by the extraordinary assembly are published in the 1946 report: the report also includes brief summaries of the activities of the various associations since the Washington meeting, a list of the officers of the Union and its component organisations, and the text of an agreement recently made between the International Union of Geodesy and Geophysics (as one of the family of the International Council of Scientific Unions) and U.N.E.S.C.O. By this agreement the International Union will play its part in disseminating information on geodetic and geophysical subjects in countries where contacts on cultural and scientific matters have hitherto been few: and in return, U.N.E.S.C.O. will use its good offices to promote these contacts by financial support for publications and meetings. U.N.E.S.C.O. has already allocated grants from its 1947 budget for this purpose.

U.N.E.S.C.O. will also help in another field of the International Union's activity. Real progress in geodetic and geophysical subjects requires the closest possible international collaboration on a long-term basis. Sound theories concerning isostasy, or the figure of the earth, concerning the nature of the internal structure of the earth as revealed by earthquakes, or the form of the earth's magnetic and electrical fields, or, again, concerning ocean currents or the circulation of the atmosphere, cannot be achieved in a year or two. In each of these fields of investigation there is a great need for a central bureau, maintained on a more or less permanent basis, where at least all the main facts can be collected and made available to those specialists, wherever they be, who are capable of studying them. Since its formation in 1919 the International Union of Geodesy and Geophysics has become responsible, sometimes with other interested unions or institutions, for maintaining several such permanent or quasi-permanent services: the International Seismological Summary, the Isostatic Institute in Helsinki, the International Latitude Service, and the Bureau International de l'Heure are examples. The maintenance of these services, with their staffs and publications, has become a continuous drain on the funds of such unions as the International Union of Geodesy and Geophysics, even to the detriment of other investigations which equally require international co-operation though on a shorter term basis. Following on the U.N.E.S.C.O. agreement, it is therefore a good omen for future development in geodetic and geophysical science that U.N.E.S.C.O. will try to allocate grants for these bureaux and so relieve the International Union to

* International Union of Geodesy and Geophysics. Report for the War Years 1939–45, with the proceedings of the Executive Committee of the Union, Oxford, December 1945, and the Extraordinary Assembly, Cambridge, July 1946. Published by the Bureau of the Union at Kew Observatory, Richmond, Surrey.

engage in the many other important problems which await investigation.

With the example set by the parent union at its 1946 assembly, many of the International Union's associations have had meetings of their own executive committees and councils to put their post-war houses in order and to make plans for the next general assembly, which will be held in Oslo during August 19–28, 1948. Partly in anticipation of that assembly and partly to renew and extend interest in the work of the Union, a pamphlet describing its organisation and scientific activities and those of its constituent associations and commissions has just been published by the Union's Bureau (at present at Kew Observatory, Richmond, Surrey), where copies can be obtained.

THE SWEDISH DEEP-SEA EXPEDITION

By Prof. HANS PETTERSSON

THE Swedish Deep-Sea Expedition left Göteborg on July 4 on board the 1,400-ton motor-schooner *Albatross*, which had been specially fitted out for the purpose at the Lindholmen shipyard with air-conditioned laboratories and accommodation for the scientific staff, dark rooms, workshops, cold-storage room, electric winches, etc. The main purpose of the cruise, which is expected to last for fifteen months, is to investigate the deep ocean bed and its deposits by means of new methods developed in Sweden during the war years. The first part of the cruise, between Madeira and Panama, has now been completed. Some of the results are here briefly summarized.

A new and powerful echo-sounding equipment has been constructed for the *Albatross* by the Marine Instruments, Ltd., of London (formerly Henry Hughes and Sons, Ltd.), in order to get detailed and continuous records of the depth down to at least 7,500 metres. The records so far obtained go down to more than 6,000 metres and are very interesting. They prove that older views of the deep-sea bottom as a smooth, perfectly level surface, especially in the depressions, are radically wrong, at least as regards the part of the Atlantic Ocean which has been traversed. Such surfaces extending over several miles of our course were comparatively rare. Instead, the depth curve moves incessantly up or down, generally by gentle undulations but quite often rising or falling by distinct steps, 100 to more than 300 metres high and from less than one nautical mile to a few miles broad. The change in depth is sometimes so abrupt that the recorder cannot follow it, thus indicating nearly perpendicular walls hundreds of metres in height. One gets the impression of fault lines stretching more or less obliquely across the course. In other cases the slope is steadier, rising or falling by as much as 1 : 10, or even steeper. In certain places where the record tends to become confused, the bottom appears to be covered with small hills or hummocks, the record showing three or more convex lines, partly overlapping or intersecting at one point.

Crossing the central Atlantic Ridge, where the bottom was pronouncedly uneven and rich in steps or hummocks, its highest point found by us, quite close to the place where the Admiralty chart has the depth of 934 fathoms, in lat. 23° 10′ N., long. 45° 10′ W., has a minimum depth of only 786 fathoms or about 1,440 metres. Evidently a close net of echograms will be required for any detailed study of the morphology of the Atlantic bottom.

In the Caribbean Sea the depth curve along our course from Martinique to Panama was much steadier than in the open Atlantic, hummocks and steps in the curve were rare, and the depth remained constant to within a few fathoms over distances of 50–100 nautical miles or even more. It is interesting to note that bottom features similar to those of the Caribbean were found also between Algiers and the Tyrrhenian Sea by the Swedish Expedition to the Western Mediterranean on board the *Skagerak* in 1946.

This surprising unevenness of the deep Atlantic bottom proved a serious complication in our attempts to measure the thickness of the sediment carpet by the method developed by Prof. W. Weibull of Bofors, who accompanied the Expedition to Panama. By means of depth charges detonating at depths of 500, 2,500 or 4,500 metres below the surface, echoes are set up from the bottom itself as well as from reflecting surfaces deeper down in, or below, the sediment. Hydrophones of special construction suspended from the ship convert the sound-waves into electric impulses which are recorded on an oscillograph. Where the bottom profile is rough, diffuse reflexions obscure the oscillograms, whereas over a smooth bottom 'deep echoes' may be recorded. The values found (uncorrected for the somewhat higher velocity of sound in the sediment than in water) vary in the open Atlantic between 300 and nearly 2,500 metres.

In the Caribbean Sea, with its much smoother bottom, the oscillograms are very clear and give values which increase from east to west, from 250 metres to a maximum of 900 metres. The total depth of the reflecting surface, presumably the rocky floor beneath the sediment carpet, thus varies between 4,800 and 7,800 metres in the Atlantic and between 2,900 and 5,600 metres in the Caribbean Sea. In the western Mediterranean the maximum depth of a reflecting surface found in 1946 right in the centre of the Tyrrhenian Sea was 2,600 metres at a water depth of 3,600 metres. It will be of interest to continue these measurements also in the central Pacific Ocean, where we intend also to use depth charges exploding in the sediment itself.

Dr. B. Kullenberg, by means of his piston core-sampler, has taken some dozen cores from depths between 4,000 and 5,600 metres, most of them 10–15 metres long. Some of those taken in the open Atlantic in depths of 5,000 metres or more consist of red clay, which becomes very compact and takes on a deep chocolate-brown colour in the lower levels. Occasionally layers rich in Foraminifera are found intercalated in the red clay. Assuming the latter sediment to increase in thickness by 8 mm. in 1,000 years in the Atlantic Ocean, the lower strata of a core 15 metres long should have been deposited nearly two million years ago, or before the end of the Tertiary Age, when the deep ocean water is generally assumed to have been considerably warmer than during the Quaternary Age. This would seem to make it difficult to uphold an opinion prevalent among oceanographers, namely, that the lime-dissolving effect of the ice-cold Antarctic bottom current is the main or only agency capable of converting calcareous ooze into red clay.

In a 15-metre long core taken from a depth of nearly 4,900 metres at the centre of the Caribbean

Sea, the sediment has a strong greenish hue and displays an interesting stratification, with layers alternately rich and poor in calcareous shells. Dr. Fred Phleger, of the Woods Hole Oceanographic Institution, who was the guest of the Expedition between Martinique and Panama, sampled this core for Foraminifera and also collected plankton from the uppermost 1,000 metres of water by means of tow-nets of special construction.

Hydrographic soundings with temperature observations, also by means of the bathythermograph, and with water samples for chlorine and oxygen determinations were made across the Caribbean. Large-volume samples were taken from various depths, both in the open Atlantic and in the Caribbean, for measurements of uranium and radium. Such measurements have become of especial importance owing to the light they may shed on the ionium precipitation in the sea, which is supposed to be responsible for most of the radium present in deep-sea deposits.

The cores hitherto taken by the Expedition are being sent back to Sweden for analyses by various specialists. The *Albatross* now leaves for the Pacific part of the cruise, with the Galapagos Islands as the nearest goal.

OBITUARIES

Dr. S. H. Daukes, O.B.E.

By the death of Sidney Herbert Daukes, the medical profession has lost its leading authority on the modern medical museum. Daukes died on September 3 after a short illness. The son of the Rev. S. Whitfield Daukes, vicar of Holy Trinity, Beckenham, he was born on April 20, 1879. He was educated at Lancing College where he distinguished himself in various sports, and at Caius College, Cambridge. He took a second class in the Natural Science Tripos in 1900 and then studied medicine at the London Hospital. He qualified M.R.C.S., L.R.C.P. in 1905 and in the same year graduated M.B., B.Ch., Cambridge. After several years spent in hospital appointments and in general practice, he took his D.P.H. in 1912 and in 1913 the D.T.M. & H. By the outbreak of the First World War he had held a post as assistant school medical officer at Leeds and was chief assistant school medical officer for Norfolk.

In the War, Daukes served first as a special divisional sanitary officer in France. In the winter of 1917–18 the War Office established the School of Army Hygiene at Leeds, and Daukes was made responsible for its organisation and administration. He was mentioned in dispatches and received the O.B.E. in 1920. He wrote "A Manual of Sanitation Applied to Military Life", and he contributed the chapters on hygiene to the official medical history of the War.

After the War, Col. Andrew Balfour—later Sir Andrew Balfour—who was director of the Wellcome Bureau of Scientific Research, invited Daukes to become curator of the Museum of Tropical Medicine which had been established by Sir Henry Wellcome. Under Daukes' guidance its scope expanded, and in 1926 it became the Wellcome Museum of Medical Science, with Daukes as its first director.

Daukes held very strong views on the importance of visual education, and he organised his museum with this end in view. Each disease was dealt with as an entity, and in the bays devoted to it, the student could follow out the latest views on etiology, pathology, clinical features, treatment and prevention, each branch being illustrated by photographs, charts, pathological specimens, paintings and other visual representation which was calculated to impress the point in question on his mind. The Museum became an important teaching unit, and it was visited by many medical men from overseas, by practitioners proposing to specialize in tropical medicine, by medical students and by nurses and health visitors. In the years immediately preceding the Second World War, approximately 10,000 persons visited the Museum annually. The Ministry of Health included a demonstration of tropical diseases in the Wembley Exhibition in 1924, and this was largely planned by Daukes acting as organising secretary of the appropriate committee. Similar exhibits were sent to the Wembley Exhibition in 1925, to Antwerp in 1929 and to Paris in 1931. In 1928 Daukes graduated M.D. at Cambridge with a thesis on the medical museum. This thesis was later expanded and published as an important monograph. In 1940 Daukes was asked to take over, as a temporary measure, the administration of the Wellcome Historical Museum, the directorship of which had been held by Sir Henry Wellcome himself until his death.

Daukes was well known, under his pen name "Sidney Fairway", as a novelist with a wide popular appeal. His novels generally dealt with some aspect of medical life, his best known being "The Doctor's Defence" and "The Cuckoo in Harley Street". His last novel, "He Loved Freedom", was published a week or so before his death. His reminiscences will be published shortly with the title "A Pillar of Salt".

He married Emma, daughter of William Kempsell of Reigate, who died in 1944. In 1945, he married Ethel Maud, widow of E. J. T. Hoyle of Doncaster. He is survived by his widow and a son by the first marriage, Lieut.-Colonel Whitfield Daukes, R.A.M.C.

E. Ashworth Underwood

Prof. V. Ulehla

The many-sided Czechoslovak man of science, Vladimir Ulehla, died on July 3 at the age of fifty-eight. His father had taken a prominent part, years ago, in securing educational reforms in Moravia, and Vladimir's interest in science was further developed under Prof. B. Němec at Prague and at the University of Strasbourg. After 1919, Dr. Ulehla became professor of plant physiology and biology at the newly founded Masaryk University of Brno. His original contributions to science relate mainly to a study of protoplasmic movement in lower organisms, and the influence of various ions on cells and their protoplasm. The borderline of plant and animal life, and the infusoria especially, interested him and he made some physico-chemical investigations on plant colloids and on turgor. Ulehla also wrote two books in Czech of a philosophical nature, "Reflexions on Life" and "Beyond the Veil".

But Ulehla's special merit was his skill in interesting the general public of his country in science and culture. His first great opportunity came when he was the organiser of the remarkable Brno Contemporary Culture Exhibition of 1928. Moravia was then a centre of archæological interest on account of the recent discoveries concerning the prehistoric mammoth hunters. Thanks to Ulehla's organising ability the exhibition, which attracted international atten-

tion, gave a clear impression of Czechoslovakia's cultural and scientific progress during the first decade of its independence.

Next, Ulehla turned his attention to the production of educational and cultural films, and those depicting the colourful peasant life and scenery of south-east Moravia, where the Slovak inhabitants cling to their traditional dress and old customs and folklore, were particularly successful.

In addition to his duties at Brno University, Ulehla was from 1928 until 1939 scientific correspondent of the daily *Lidové Noviny*, and he resumed this work in 1945 when the journal reappeared as *Svobodné Noviny*.

J. G. F. D.

We regret to announce the following deaths:

Sir Albert Howard, C.I.E., Imperial economic botanist to the Government of India during 1905–24, director of the Institute of Plant Industry, Indore, during 1924–31, on October 20, aged seventy-four.

Dr. Ellsworth Huntington, formerly research associate in geography, Yale University, an authority on the effect of climate on human racial development, on October 16, aged seventy-one.

NEWS and VIEWS

Physiology at Charing Cross Hospital Medical School: Prof. William Burns

Prof. W. Burns, recently appointed to the chair of physiology at Charing Cross Hospital Medical School, London, is a graduate in science and medicine of the University of Aberdeen. He received his early education at the Mackie Academy, Stonehaven, whence he entered the University in 1930. Having graduated B.Sc. in 1932 and M.B., Ch.B. in 1935, he was appointed to an assistantship in the Department of Physiology, and in 1938 became senior lecturer. As a teacher and demonstrator, Burns brought to an orderliness of thought and expression the valuable gift of artistic skill in illustration. Prof. Burns' first interest in research work centred around the problems of carbohydrate and cardiac metabolism, but it soon became manifest that his chief interests lay in the realm of the biophysical. Until 1942 he was engaged in investigating activity in afferent nerves associated with the viscera. The results of this work were incorporated in a thesis for which he was awarded the D.Sc. degree.

Early in 1942, Prof. Burns' biophysical and technical interests suggested a potential usefulness in the war effort, and in that year he was called to the Admiralty. After a period of service at the Admiralty research laboratory, he was appointed physiologist on the staff of the headquarters of the Royal Naval Scientific Service and latterly was placed in charge of the Royal Naval Physiological Laboratory. During the period of his war service, he was engaged on various problems such as the application of acoustics, the habitability of submarines, operational considerations affecting special equipment in warships, etc. In the latter years of his Admiralty service, he was also responsible for liaison between the Royal Naval Scientific Service headquarters and the activities of the Royal Naval Personnel Research Committee of the Medical Research Council, in which the latter is associated with the Admiralty in dealing with problems involving the relationship of man to the various duties and types of environments imposed by the requirements of the Navy.

Walter Holbrook Gaskell (1847–1914)

One hundred years ago, on November 1, 1847, Walter Holbrook Gaskell was born at Naples. Gaskell was a physiologist to whom medicine continues to owe a deep and lasting debt. He was a mathematician by training, and on Michael Foster's advice he went in 1874 to Leipzig to Ludwig's laboratory, in those days the most important centre of physiological research in Europe. On his return he took up physiology as a career, being appointed lecturer at Cambridge in 1883. Gaskell laid the secure foundation for our knowledge of the pathology of the heart and of the autonomic nervous system. In a series of ingenious and conclusive experiments he showed that the beat of the heart is due to automatic rhythmic contractions of the heart muscle and to the wave of excitation flowing from sinus venosus to bulbus arteriosus and from muscle fibre to muscle fibre. By his zigzag incisions of heart muscle he proved the continuity of the rhythmic wave. He introduced the terms and conceptions 'heart block', 'fibrillation', and 'gallop-rhythm' into the literature, and was one of the pioneers in the galvanometric investigation of the heart. In 1890, at the request of the Hyderabad Commission, he investigated the action of chloroform. His fascinating book "The Origin of Vertebrates" appeared in 1908. As a lecturer Gaskell was popular and inspiring, though he was not eloquent. A big man physically and intellectually, his strength and his weakness lay in his love of generalizations, which sometimes led him to victory and as often led him astray. He died on September 7, 1914, in his sixty-seventh year.

George Green, 1793–1841

As a mathematician, George Green is among the immortals; as a man he sank back almost at the moment of his death into the obscurity from which he had startlingly emerged. From a volume of studies published in 1946 as a tribute to George Sarton, Mr. Gwynedd Green, of University College, Nottingham, has separated a biography of the miller-scholar who graduated as fourth wrangler at the age of forty-four, nine years after the private publication of an incomparable masterpiece. Property is located, wills are transcribed, correspondence between Kelvin and Crelle is reproduced, and there are notes on every traceable name in Green's family tree and on all but eight of the fifty-two subscribers to the printing of the famous "Essay"; bibliographical information is thorough, but mention should surely have been made of the collected edition of Green's papers which was prepared by Ferrers for Caius in 1871 and reproduced photographically in Paris in 1903. The circumstances of Green's life both in Nottingham and at Cambridge have been investigated once for all from local sources with an industry beyond praise, and if a condescending patron and a resentful daughter are more vivid in the story than the central figure himself, this is because no contemporary portrait or character sketch has been found and the author does not attempt imaginary reconstructions. It is sad to learn from a note added in manuscript that the mill in which Green laboured and studied was reduced to a shell by fire in July last.

Department of Scientific and Industrial Research: Activities in Scotland

THE view has been held by many that great benefits could accrue from the establishment of branches of the existing stations of the Department of Scientific and Industrial Research, or of new laboratories, in different parts of Great Britain. By such developments, the work of these stations could be brought more intimately before the notice of industrialists, practising engineers and others, and it would be more convenient for them to obtain the greatest benefit from the researches in progress by the most effective method—that of direct consultation and discussion with the staffs concerned. There is also the important argument that the research establishments themselves would be able more readily to appreciate the needs of industrial concerns and authorities in different places.

Accordingly, the announcement recently made concerning the establishment in Scotland of the new Mechanical Engineering Research Station and of substations for fuel, building and road research will receive wide approval. There is in Scotland, of course, a long and distinguished tradition of engineering activity of every description. In addition, there are schools of engineering science within its four universities and at various technical colleges. These schools have already established a high reputation for their teaching and for their original work; they are anxious to develop the research side of their function, and the closer contact afforded with the Department of Scientific and Industrial Research by the new developments will be helpful in this direction. Nor can it be denied that the Department itself will stand to gain from making its points of contact with all universities more numerous and more personal.

New Vegetable Research Station

THE first meeting of the governing body of the new Vegetable Research Station was held at the offices of the Ministry of Agriculture on October 8. Its incorporation as a company limited by guarantee and not having a share capital was decided on and an organising committee was set up to select suitable candidates for the post of director and to examine suitable sites for the Station; it is considered that an area of at least 300 acres would be necessary. The members of the governing body are Sir Edward Salisbury, Dr. W. G. Ogg, Prof. G. E. Blackman, Dr. H. V. Taylor, Mr. R. L. Scarlett, Dr. J. Barker, Prof. J. W. Munro, Prof. R. H. Stoughton, Prof. F. T. Brooks, Prof. T. Wallace, Prof. S. J. Watson, Prof. W. Brown, Dr. C. D. Darlington, Mr. E. H. Gardener, Mr. G. G. Hole, Mr. W. F. Swift, Mr. J. Laity, Mr. A. A. Clucas, Mr. David Lowe, Mr. J. Cracknell, Mr. F. A. Secrett and Mr. G. W. Giles.

Agriculture in the Caribbean

THE Anglo-American Caribbean Commission was set up in 1942 to encourage social and economic co-operation between the United States of America and its possessions and bases in the Caribbean, and the United Kingdom and the British Colonies in the same area. In 1945, the Governments of France and the Netherlands accepted an invitation to join this body, which has since become known as the Caribbean Commission. The committee set up by its Research Council to deal with problems connected with agriculture, nutrition, fisheries and forestry has circulated a number of crop inquiries to the various agricultural departments and is issuing a series of publications based on the replies. "Grain Crops in the Caribbean", the third in the series, is now available on request from the Caribbean Research Council, Caribbean Commission, Kent House, Port of Spain, Trinidad, B.W.I. For four hundred years the agricultural systems have been largely based on single-crop agriculture for the export market. The obvious dangers of this policy and the advantages of diverse cropping have been repeatedly pointed out, and the cessation of rice imports from Burma and India during the War forced attention on the necessity for producing more food for home consumption and the desirability of encouraging inter-Caribbean trade. With the exception of rice in the Guianas and maize in British Honduras and Jamaica, both acreage and production of grain crops are normally very small. Methods of cultivation are primitive, manures are rarely used and losses are heavy owing to inadequate storage facilities. The general conclusion from the inquiry, however, is that though greater attention to fundamental research is of the utmost importance, the introduction of machinery and the application of existing knowledge could immediately bring about a substantial increase in grain production without reducing the acreage devoted to export crops.

A Central Library of the World

A PROJECT for a Central Library of the World, drawn up during the German occupation of France, with the dual objects of providing more effectively for the preservation of the documents on which human culture rests and making their utilization easier and more widespread, is of interest in relation to the programme of work now contemplated by the United Nations Educational, Scientific and Cultural Organisation, which already includes a library organisation. Of the seven stages in which it was visualized the project would be achieved, the first, that of bringing together in France a limited number of initiators, both French and foreigners resident in France, had been realized; and a second, that of formulating a concrete project and inviting the collaboration of a number of well-known French personalities, was in progress when this pamphlet was issued by the French Association for the Study of Bibliographic Questions (7 rue des St.-Pères, Paris 7), as was the fourth stage of inviting foreign co-operation. The further stages include the formation of an international committee and, after study of the problem by that committee, an international convention to set up the appropriate organisation, appoint the members and to decide on the official language to be used.

The preliminary scheme summarized in this pamphlet contemplates the establishment of the organisation, to be called the Bibliothèque Centrale du Monde, by a statute guaranteeing the absolute inviolability of the headquarters of the Organisation, which is to be regarded as a world reserve; the territory where it is located should belong to no nation. The organisation would be directed by a supreme council, and administered by an administrative council. Its director would be provided with a general secretariat and would also be responsible for the administrative, principal and auxiliary services. Besides ordinary members of council, there would be from three to ten times as many corresponding members. The supreme council would function largely through two permanent commissions, one of which would be responsible for the study of projects. The chief services contemplated

include the deposition and distribution of documents, and diffusion of information. In particular, it is suggested that the organisation should provide at its central depot a universal primary bibliography, and should endeavour to secure the creation of a universal copyright system. It seems that with the establishment of the United Nations Educational, Scientific and Cultural Organisation, the proposals should, in the first instance, be considered by that body, presumably at the instance of one or other of the national delegations.

Literature of Spectrochemical Analysis

THE American Society for Testing Materials, through its Committee on Spectrographic Analysis, has sponsored the publication of two indexes on the literature of spectrochemical analysis. The first, issued in 1940, covered the years 1920–39 and contained 1,467 references and a detailed subject index. The second, "Index to the Literature on Spectrochemical Analysis. Part II, 1940–1945", issued in January of this year, gives references to 1,044 publications on spectrochemical analysis that have appeared during the years 1940–45 inclusive. In addition, there are thirty-six references, for the years 1938 and 1939, that were omitted from the earlier Index. The references are arranged in chronological order, and for each year the material is listed in alphabetical order according to the authors. English titles are given for all the papers, but foreign book titles are left untranslated. In the earlier Index abstracts were not given but only references to the published abstracts of the papers. Because of the widely scattered nature of the literature, and because many libraries probably lack complete sets of foreign periodicals for the war years, a brief abstract is provided, in Part II, for every spectrochemical publication listed. In most cases the abstracts are quoted verbatim from *Chemical Abstracts*, but where necessary, by consulting other abstracting journals and the original articles, a more suitable abstract has been compiled. This painstaking and intensive work, both of maintaining and compiling the Index, has been done under the direction of B. F. Scribner and W. F. Meggers, of the National Bureau of Standards, Washington. A helpful, detailed subject index, which covers the content rather than the titles of the several papers, completes the Index.

It is somewhat surprising that in spite of war-time restrictions on publication and the difficulties of access to foreign journals so much work has been done in the field of spectrochemical analysis during the War. The choice of spectrochemical methods in preference to others can only be attributed to the simplicity, speed, sensitivity and economy of these methods—all vital factors in war-time applications. With the return of industrial competition, these methods should prove equally valuable, and all spectrographers will find both Part II and the earlier Index indispensable as reference handbooks. The Index is clearly printed and bound in a paper cover, though for reference purposes in the laboratory it would have been preferable to have had a much heavier binding. Abbreviations are used extensively, and although no explanatory list is provided, no real difficulty will be experienced in understanding the text. The addition of a list of the full titles and addresses of periodicals to which reference is made would perhaps be an improvement. Copies of the Index can be obtained from A.S.T.M. Headquarters, 1916 Race Street, Philadelphia 3, Pasadena.

Nature Lover: The Magazine of the Countryside

THE recent publication of volume 4, No. 1 of *Nature Lover*, the magazine of the countryside, marks the revival of a much-needed popular journal which deals with the natural history and archæology of the British countryside. The greatest merit of the journal is that it chooses good, representative subject-matter which is fairly easily available, thus bringing these rural sciences within the reach of everyman. The present number contains short, readable articles on the "Unity of Nature" by C. H. Warren, "Secretive Badgers" by B. M. Nicholas, "British Fritillary Butterflies" by L. H. Newman, "Jimmy the Lizard" by Frances Pitt, "The Numbers of Animals" by Brian Vesey-Fitzgerald, "Water Problems of Fishes" by Chapman Pincher, "Some Strange Plant Habits" by Wolseley Banks, "Bird-watching on an East Coast Estuary" by R. H. Harrison, "Lavenham, Suffolk" by Geoffrey Morgan. Among these authors are some of Britain's best natural history writers, and some of the articles are illustrated by good photographs. This monthly journal can be strongly recommended to the general lay reader who is interested in country-life and natural history, and it should be encouraged in all our secondary schools, for its method of presentation is bound to stimulate interest. Subscription to *Nature Lover* is 16*s*. 6*d*. a year, including postage. Further information can be obtained from *Nature Lover*, Staples House, Cavendish Place, London, W.1.

U.S. National Academy of Sciences: Officers

ACCORDING to the annual statement, the present officers and members of the Council of the U.S. National Academy of Sciences are as follow: *President*: Prof. Alfred N. Richards, professor of pharmacology, University of Pennsylvania; *Vice-President*: Dean L. P. Eisenhart, Graduate School of Mathematics, Princeton University; *Foreign Secretary*: Prof. Detlev W. Bronk, Johnson professor of biophysics, University of Pennsylvania; *Home Secretary*: Dr. F. E. Wright, Geophysical Laboratory, Carnegie Institution, Washington; *Treasurer*: Dr. J. C. Hunsaker, Departments of Mechanical Engineering and Aeronautical Engineering, Massachusetts Institute of Technology. *Other Members of Council*: Dr. Walter R. Miles, Prof. W. Albert Noyes, jun., Prof. I. I. Rabi, Dr. W. M. Stanley, Dean John T. Tate and Dr. D. D. Van Slyke.

Rook Behaviour during Incubation

CLOSELY studying a rookery of eight nests during the incubation period, C. M. Ogilvie noticed that the hen birds applied themselves almost exclusively to incubation, while excursions were rare and very brief. (*British Birds*, **40**, No. 5; May, 1947.) Feeding and coition, when this occurred, took place upon the nest. The cock bird was responsible for feeding the hen, a duty which was performed with characteristic ceremony at irregular intervals; intrusions within the colony and invasions from without were combated by the male birds. Coition was more often promiscuous than between mated pairs, and took the form of an assault resisted by the hen and countered by other cocks.

University of Leeds: Appointments

THE following appointments in the University of Leeds have been announced: Mr. E. A. Vaughan, lecturer in the Department of Social Studies; Mr.

A. Johnson and Mr. L. G. Johnson, lecturers in the Departments of Economics and Extra-Mural Studies; Mr. Edward Broadhead, lecturer in zoology; Mr. J. D. Jenkins, lecturer in mining; Mr. H. J. King, lecturer in surveying; Dr. W. J. Allen and Dr. R. A. Kenney, lecturers in physiology; Mr. S. Dagley, lecturer in biochemistry; Mr. G. A. Nelson, lecturer in pharmacognosy.

The number of full-time students enrolled for the present session is 2,804; the number of ex-Service students at present in the University is approximately 1,200. The present total of students compares with 1,736 in 1938; the number of arts students has increased very markedly owing to the number of students returning to complete courses interrupted by national service, but apart from this the increase is fairly uniformly spread over all departments and faculties.

University of Sheffield: Appointments

THE following appointments have been made in the University of Sheffield: Dr. A. S. C. Lawrence, senior lecturer in physical chemistry; Dr. H. J. Tress, lecturer in glass technology; H. Graetzer, assistant lecturer in mathematics; G. H. Jowett, assistant lecturer in statistics in the Department of Mathematics; J. R. Beattie, assistant lecturer in physics; Douglas W. Riley, assistant lecturer in chemistry; H. J. Whiteley, assistant lecturer in pathology.

The following resignations have been announced: Dr. J. Sinclair, senior lecturer in mining, who has been appointed to the chair of mining at University College, Cardiff; Dr. F. Bielschowsky, cancer research worker in the Department of Pathology under the British Empire Cancer Campaign, who has been appointed director of cancer research for New Zealand.

The Night Sky in November

NEW moon occurs on Nov. 12d. 20h. 01m., U.T., and full moon on Nov. 28d. 08h. 45m. The following conjunctions with the moon take place: Nov. 6d. 03h., Mars 4° S.; Nov. 6d. 07h., Saturn 5° S.; Nov. 11d. 20h., Mercury 0·03° S.; Nov. 14d. 01h., Jupiter 2° N.; Nov. 14d. 10h., Venus 1° N. In addition to these conjunctions with the moon, the following conjunctions also take place: Nov. 9d. 14h., Venus in conjunction with Jupiter, Venus 0·9° S.; Nov. 11d. 18h., Mars in conjunction with Saturn, Mars 0·9° N. Mercury is in inferior conjunction on Nov. 5 and becomes a morning star later in the month, rising at 5h. 40 m., and 6h. at the middle and end of the month, respectively. Venus, an evening star, sets about 17h. throughout November and can be seen very low in the western sky. Mars, in the constellation of Leo, rises at 23h. 08m., 22h. 52m., and 22h. 25m., at the beginning, middle and end of the month respectively, and is close to Regulus towards the end of November. Jupiter sets in the early evening hours and is unobservable. Saturn rises at 23h. 38m., and 21h. 50m. at the beginning and end of the month, respectively, and can be seen in the constellation of Leo, fairly close to Mars. Occultations of stars brighter than magnitude 6 are as follows: Nov. 1d. 04h. 25·5m., υ Taur. (*D*); Nov. 1d. 05h. 08·9m., υ Taur. (*R*); Nov. 1d. 19h. 53·0m., 103 Taur. (*R*); Nov. 2d. 05h. 33·2m., 118 Taur. *f*. (*R*); Nov. 7d. 04h. 32·1m., 46 Leon. (*R*); Nov. 21d. 18h. 17·3m., τ Aqar. (*D*); Nov. 26d. 20h. 37·0m., σ Arie (*D*); Nov. 29d. 23h. 33·0m., 139 Taur. (*R*). *D* and *R* refer to disappearance and reappearance, respectively, and the latitude of Greenwich is assumed. There will be an annular eclipse of the sun on Nov. 12, invisible at Greenwich.

Announcements

PROF. ARTHUR HOLMES, regius professor of geology in the University of Edinburgh, has been elected a foreign member of the Royal Swedish Academy of Sciences.

THE Kelvin Medal Award Committee, consisting of the presidents of the Institutions of Civil Engineers, Mechanical Engineers, Electrical Engineers, Naval Architects, Mining and Metallurgy, Mining Engineers, and Engineers and Shipbuilders in Scotland, and the Iron and Steel Institute, has awarded the Kelvin Gold Medal for 1947 to Air Commodore F. G. Whittle, in recognition of the eminent services he has rendered to engineering science in those branches of engineering work with which Lord Kelvin was especially identified. The Medal is normally presented triennially, but the last award was made in 1938 to Sir J. J. Thomson.

DR. JOSEPH ARONSON, of the United States Bureau of Indian Affairs, has been awarded the Alvarenga Prize of 1947 of the College of Physicians of Philadelphia, in recognition of his studies on the evaluation of BCG vaccine in the control of tuberculosis.

AT the invitation of the British National Committee, the fourth plenary World Power Conference will be held in London in 1950.

THE International Union of Biological Sciences, with the financial support of the United Nations Educational, Scientific and Cultural Organisation, is arranging a symposium on the role of trace elements in plant physiology, to be held at Rothamsted Experimental Station during November 5–6, 1947. Seventeen research workers from Australia, Denmark, Finland, France, Great Britain, Netherlands, Norway, Sweden, Switzerland and the United States have accepted invitations to attend. The report on this symposium will be published by the International Union.

THE Linnean Society of London, in conjunction with the Systematics Association, is organising a course of twelve weekly lectures on the "Principles and Methods of Taxonomy". Lectures will be given in the rooms of the Linnean Society on Wednesdays at 5.30 p.m., the first lecture being on October 29. Leading plant and animal taxonomists are contributing to the course, which is open to advanced students of biology. Further information can be obtained from the Assistant Secretary, Linnean Society of London, Burlington House, Piccadilly, London, W.1.

A FARADAY SOCIETY general discussion on "The Physical Chemistry of Process Metallurgy" will be held in the latter half of September 1948. It is intended that the discussion should be devoted to the thermodynamics and kinetics of the high-temperature reactions involved in smelting and refining, but excluding reactions which occur in mechanical working and heat treatment, and also electrochemical processes in aqueous solutions. Thermodynamics will include thermochemical, free energy and equilibrium studies, and kinetics will include both chemical reactions and diffusion processes. Prospective contributors should forward to the Secretary of the Society summaries of any papers they would like to submit not later than February 1.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Electron Microscope Studies of Normal and Malignant Tissues of High- and Low-Breast-Cancer Strains of Mice

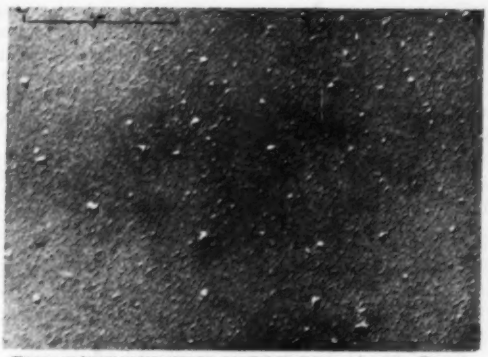
MAMMARY cancer in high-breast-cancer strains of mice has been shown by Bittner[1] to be transmissible to the offspring through the milk of the mother, and furthermore he has claimed[2] that all the tissues except the liver of high-cancer strains contain the same tumour-inducing factor as is found in the milk.

Barnum, Ball, Bittner and Visscher[3] described some of the physical properties of the milk factor present in tissues of mice of high-cancer strains. They found that petroleum ether does not destroy the tumour-inducing properties of tissues derived from high-cancer strains. They also observed that these properties remain unchanged at *p*H values between 5·0 and 10·2. According to Bittner[4], and confirmed by one of us (Dmochowski), extraction of breast-tumour tissue with distilled water is more efficient than with saline.

In June 1946, experiments were undertaken in order to examine with the electron microscope normal and malignant tissues obtained from high- and low-cancer strains.

Extracts of normal and malignant tissues from mice of *C3H*, Strong *A*, and *R*3 high-cancer strains, as well as of *C*57 black and *CBA* (which in this laboratory is a low-cancer strain), were prepared in the following way. Dried tissues were treated with petroleum ether, extracted with distilled water, treated with trypsin for 30 min. at 37° C., and filtered through Berkefeld *N* candles. The following tissue extracts were made: lactating breasts and breast tumours of *C3H*, Strong *A* and *R*3 strains; lactating breasts of *C*57 and *CBA* strains; breast tumours induced in *C*57 and in *IF* low-cancer-strain mice by methylcholanthrene; and also 37*S* transplantable sarcoma of the Imperial Cancer Research Fund, and a sarcoma induced in *C*57 by methylcholanthrene. In each case extracts of the same concentration were made, starting from equal amounts of dried tissue. Usually several tumours or lactating breasts from several mice of each strain were minced together and desiccated in the usual way[5]. In a few cases breast tumours and lactating breasts, each derived from a single mouse, were also examined. All extracts for electron microscopy were further diluted with filtered distilled water to a strictly comparable concentration, micro-drops were placed on filmed specimen grids, and the drops were drained immediately with a strip of filter paper to bring about rapid drying. After shadowing with metallic gold, the suspensions were photographed.

Results. Extracts of lactating breast tissues and of breast tumour tissues of *C3H*, Strong *A* and *R*3 strains were found to contain approximately spherical particles about 200 A. in diameter (see photograph). Extracts of lactating breast tissues from mice of *C*57 and *CBA* low-cancer strains, extracts of breast tumours induced in *C*57 and *IF* low-cancer strains by methylcholanthrene, and extracts of 37*S* sarcoma, were found to be free from such particles. Our results showed, therefore, that particles of about 200 A. diameter were consistently present



EXTRACT (PETROLEUM ETHER, DISTILLED WATER, TRYPSIN, BERKEFELD *N* CANDLE) OF *C3H* HIGH-CANCER STRAIN LACTATING BREAST TISSUE. GOLD-SHADOWED ON COLLODION FILM

in breast tissues and tumours of high-cancer strains, and consistently absent from those of low-cancer strains.

Concurrently, all extracts were inoculated into *C*57 × *R*3 hybrid mice, susceptible to the development of breast cancer. The results of these biological tests are awaited.

Since this letter was ready for publication, it has come to our notice that Graff, Moore, Stanley *et al.*[6] have examined the milk of a high- and a low-cancer strain of mice and report finding a "characteristic material of large particle size" from the milk of their high-cancer strain and its absence or low concentration in their low-cancer strain. The significance of the difference in size between the particles encountered in the two laboratories is not clear at present, nor is the relationship between these particles and the tumour-inducing factor.

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Sept. 29.

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[5] Dmochowski, L., *Brit. J. Exp. Path.*, **25**, 138 (1944); **26**, 192 (1945); **26**, 267 (1945).
[6] Graff, G., Moore, D. H., Stanley, W. M., Randall, H. T., and Haagensen, C. D., 4th Intern. Cancer Research Congress, Sept. 2–7, 144 (1947).

Specimen Changes due to Electron Bombardment in the Electron Microscope

WE have recently observed changes in a number of substances, chiefly ionic crystals, when subject to intense electron bombardment in the electron microscope. While the results are not readily interpretable, they do suggest that the effects may not be entirely due to the heating effect of the electron bombardment. It is for this reason, as well as for recording a type of artefact that has hitherto received little attention in the literature, that we report them here.

Using a cathode-biased electron gun[1,2] on the electron microscope built in the University of Toronto in 1944[3], it has been possible to obtain current densities at the specimen of the order 1 amp. per cm.^{2}, with accelerating potentials of 40–50 kV. With specimens mounted on 100 A. 'Formvar' films, the following changes have been observed.

Sodium chloride, sodium chlorate, potassium bromide and potassium iodide. The crystals, originally opaque, became transparent under electron bombardment (Figs. 1, 2 and 3). A residue was left behind which we believe to be the contaminating material discussed by Stewart[4] and Watson[5]. In some cases (Fig. 4) a deposit was formed around the crystal during the above change, and occasionally this deposit would itself later become more transparent.

Silver chloride. Under bombardment these crystals became transparent and produced an extensive deposit around them of fine opaque particles. These particles under bombardment later coalesced into a series of 'veins' with tributaries.

Lead chloride. Following a suggestion from Dr. James Hillier, at the R.C.A. Laboratories, Princeton, N.J., we examined evaporated films of lead chloride. Under bombardment this material gathers into globules which move on the 'Formvar' film.

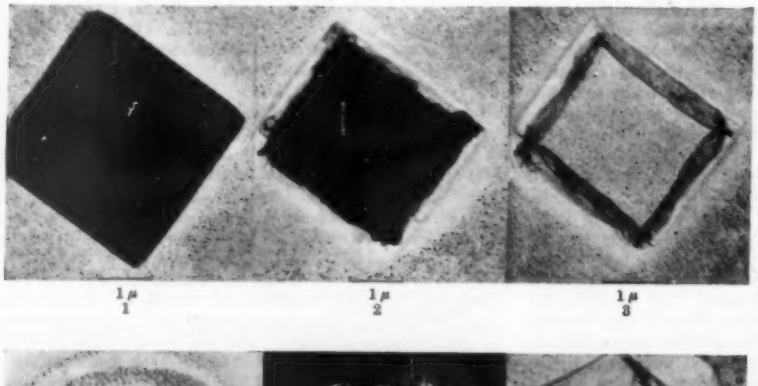
With both sodium chloride and silver chloride it has been observed on occasion that when a crystal is bombarded with electrons and becomes transparent, forming a deposit in its vicinity, other crystals within the deposit throw shadows. While at first sight it is tempting to attribute these changes solely to sublimation or melting of the crystals, there is evidence which makes this hypothesis doubtful. Hall[6] has determined the sublimation temperatures for the following substances *in vacuo*, the first temperature being for slow sublimation, the second for rapid sublimation: trinitro-*m*-cresol, 80° C., 90° C.; anthracene, 105° C., 120° C.; carbazole, 125° C., 130° C.; anhydrous citric acid, 137° C.; 150° C. melts, 150° C. boils. Hall has also examined the changes in the substances under bombardment in the electron microscope. Mounting them on 'Formvar' films and examining in our microscope, we concluded, in agreement with Hall, that specimen temperatures could be made as high as 150° C., but at this temperature the 'Formvar' films would begin to melt.

Calculations similar, though less detailed than those of Borries and Glaser[7], indicated that the temperature of the ionic crystals mentioned above would never be more than 10° C. in excess of the temperature of the supporting film. This implies that the temperature of the crystals is too low for sublimation at pressures of the order of 10^{-4} to 10^{-5} mm. of mercury.

To check this point sodium chloride crystals were mounted on a 'Formvar' film on a mesh and heated *in vacuo* outside the microscope. It was possible to melt the 'Formvar' film at the centres of the mesh openings without subliming the salt. The fact that the salt had not sublimated was established by shadow-casting the crystals before heating them and then examining the specimen in the electron microscope after heating it. There were crystals present for all the shadows present; yet after this it was possible to make some of these salt crystals disappear under electron bombardment without damaging the film.

In view of the difficulties of explaining these changes on a hypothesis of sublimation alone, we have considered that ionic migration may play a part in the change. Fig. 5 shows a crystal of sodium chloride at an intermediate state of the change. Had the process been sublimation, one would have expected those parts of the crystal more remote from the supporting film, and therefore at a higher temperature, to disappear first. The reverse seems to be the case, which is not unexpected if the phenomena is due to migration.

Fig. 5, incidentally, would seem to provide evidence in support of the theory of a mosaic texture of rock salt discussed by Ewald and Renninger[8]. In addition to the interest in the fundamental nature of this phenomenon, there is the possibility of employing it in the study of crystal surfaces, either by examining the residual contaminating layers (Fig. 6) as a replica of the surface, or by shadow-casting the crystals to produce an all-metal replica and then removing the crystal from the replica by electron bombardment within the microscope.



SODIUM CHLORIDE CRYSTALS

We hope to extend these studies and publish a fuller report on them in the future.

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R. S. Sennett
S. G. Ellis

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Canada.
July 22.

[1] Hillier, J., and Baker, R. F., *Appl. Phys.*, **17**, 12 (1946).
[2] Ellis, S. G., *J. Appl. Phys.* (in course of publication).
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[4] Stewart, R. L., *Phys. Rev.*, **45**, 488 (1934).
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[7] Borries, B. V., and Glaser, W., *Kolloid. Z.*, **106**, 123 (1944).
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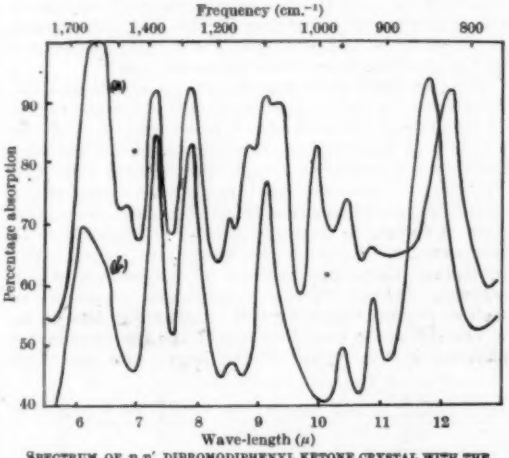
Use of Polarized Radiation in Infra-Red Analysis

In a recent communication in *Nature*, Elliott and Ambrose[1] have reported the use of a pile of selenium films for producing polarized infra-red radiation, and mentioned some interesting applications of their technique. They refer only to the previous work in this field of Ellis and Bath[2], who used a calcite prism, which restricts observations to the near region infra-red (up to 2·4 μ). The use of reflexion from a selenium mirror to produce completely polarized infra-red radiation over wave-lengths up to about 14 μ was discovered by Pfund[3] in 1906, and this method has been employed by several observers[4] in the examination of crystals of inorganic salts. We have for some time been using the Pfund reflexion technique very successfully in the study of oriented solids of organic materials. Until further details are available, it is not possible to decide whether a reflexion or a transmission technique is the more efficient with selenium, but it seems certain that the technique of producing, handling and transporting stout selenium mirrors is much easier than that required for delicate films a few microns thick.

Our results will be described in detail elsewhere, but it may be worth mentioning here that very significant differences have been observed in the spectra of thin oriented films of various polymers (for example, rubber, polythene, rubber hydrochloride and polyvinylidene chloride) for many of the bands between 6 μ and 15 μ, depending on whether the plane of polarization of the incident radiation is parallel or perpendicular to an axis along which orientation is occurring. We produced the orientation by stretching in the case of rubber and polythene, whereas for rubber hydrochloride and polyvinylidene chloride, it had already been produced by the rolling action used in making the film.

The orientation effect was checked by X-ray examination of the films and, as might be expected, the polarization effects were greatest in those cases where X-ray examination indicated a high degree of orientation. In certain cases, the interpretations of the changes in the absorption bands are quite clear. For example, the band at 6 μ in rubber arising from the stretching vibration of the C=C bond is intensified when the electric vector is parallel to the direction of stretching. Again, in polythene, the band at 6·9 μ due to the symmetrical deformation vibration of the hydrogens in the CH_2 groups is intensified where the electric vector is perpendicular to the axis of stretching. This is even more marked in the 13·9 μ band, recently shown[5] also to involve a deformation motion of the CH_2 group, and proves it to be perpendicular to the chain axis. The behaviour of the well-known hydrocarbon band at 7·3 μ (generally assigned to a symmetrical deformation vibration of the CH_2 group) appears to be anomalous and requires further investigation. As Elliott and Ambrose have remarked, the behaviour of many bands under polarized radiation may be a valuable guide in making assignments to particular modes of vibration in complex molecules for which a complete analysis of the spectrum is impracticable.

There is another aspect of the use of polarized infra-red radiation which does not yet seem to have been appreciated[6], namely, its use in conjunction with X-ray analysis to establish the orientation of a molecule in the unit cell of a crystal. Certain chemical bonds (for example, CH, OH, NH and C = C, C = O, C = N) give highly characteristic absorption bands in the infra-red; using polarization techniques, the actual orientation of such bonds can be established provided a molecule possesses in its spectrum a band which can be unequivocally assigned to a certain chemical bond or a definite vibration of a group, and thus the orientation of the whole molecule in the unit cell can be determined.



Spectrum of *p,p'* dibromodiphenyl ketone crystal with the electric vector (*a*) parallel to the *b*-axis, (*b*) perpendicular to that axis

We have recently had a good demonstration of this in the case of *p,p'* dibromodiphenyl ketone, the X-ray analysis of which is now being completed by Dr. Toussaint of the University of Liège. Dr. Toussaint required confirmation of his analysis, which placed the CO bond along the *b*-axis of the crystal. This we were able to provide, as shown in the accompanying figure, which gives the spectrum of the compound with the electric vector (*a*) parallel to the *b*-axis, (*b*) perpendicular to that axis. It will be observed that the CO band near 6 μ in case (*a*) shows 100 per cent absorption, whereas in case (*b*) it only reaches 70 per cent. The difference is much more striking than these figures indicate, because the crystal employed had to be very thick (about ten times that generally used for a CO band). The 70 per cent absorption in the perpendicular orientation is really a small residual effect due either to imperfection in the crystal

or to incomplete alignment of the axis of polarization perpendicular to the *b*-axis of the crystal.

We are indebted to Dr. Toussaint for permission to quote his results before publication, and to Mr. Clews for help in carrying out X-ray examination of some of the polymer films.

G. B. B. M. Sutherland
A. Vallance Jones
Laboratory of Colloid Science,
Cambridge. June 28.

[1] Elliott, A., and Ambrose, E. J., *Nature*, **159**, 641 (1947).
[2] Ellis, J. W., and Bath, Jean J., *J. Chem. Phys.*, **6**, 221 (1938).
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[5] Sheppard, N., and Sutherland, G. B. B. M., *Nature*, **159**, 739 (1947).
[6] *Note added in proof.* Since this letter was submitted, a similar observation has been published by D. A. Crooks, *Nature*, **160**, 17 (1947).

Temperature Variation of the Second-Order Raman Spectrum of Crystals

Investigating at different temperatures the spectrum of second-order scattering of crystals of the alkali-halide salts, we have detected some new peculiarities in the intensity distributions. The region of small frequencies of the spectrum of second-order scattering depends far more strongly on the temperature than the region of large frequencies. The photographs and the microphotometrical curves of the spectrum of scattering of the rock-salt crystal obtained by us at 250° C. and 700° C., and reproduced in Figs. 1*a* and *b*, confirm this statement.

Figs. 1*a* and *b* show that the decrease of intensities observed at a low temperature (250° C.) in the region of frequencies from 60 cm.$^{-1}$ up to 200 cm.$^{-1}$ of the continuous spectrum (marked by an arrow) becomes scarcely noticeable at a high temperature (700° C.). The curve of intensity distribution rises considerably in this region, whereas the trend of the high-frequency part of the curve does not change significantly with temperature. Thus in the spectra of second-order scattering there are regions of frequencies which strongly depend on the temperature variation, as well as regions which depend considerably less on it.

The difference combinations of the frequencies are situated in the region of the continuous spectrum

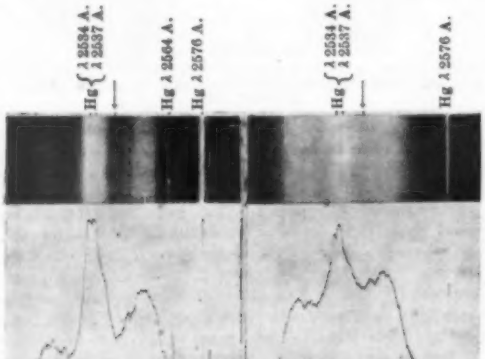

Fig. 1. Spectrum of second-order scattering of a crystal of heated rock-salt, with (below) microphotometric record. (*a*) Temp. 250° C.; (*b*) temp. 700° C.

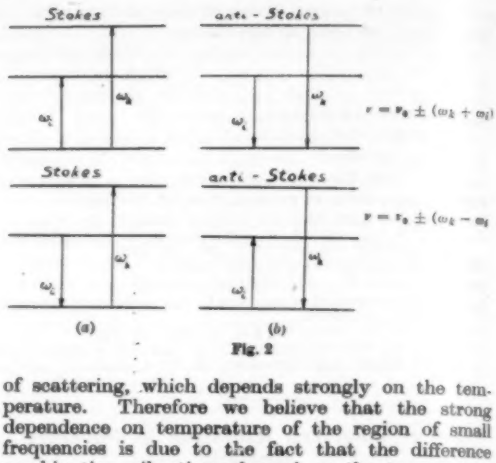

Fig. 2

of scattering, which depends strongly on the temperature. Therefore we believe that the strong dependence on temperature of the region of small frequencies is due to the fact that the difference combination vibrations depend on the temperature in a different manner and far more strongly than the octave and sum combination frequencies, which lie chiefly in a part of the spectrum of scattering more removed from the Rayleigh line.

This strong temperature-dependence of the difference frequencies can be explained in the following way. At the appearance of the Raman spectrum of the second order, the incident radiation of the frequency ν_0 (the exciting quantum) interacts simultaneously with two proper vibrations of the lattice with the frequencies ω_i and ω_k. Either a Stokes or an anti-Stokes radiation in the scattered light of the frequency ν arises, owing to the exchange of the energies between the light quantum and the vibrations of the lattice. The energy transitions also taking place in the crystal lattice during these processes and leading to the formation of the sum and difference frequencies in the Raman spectra of the second order are illustrated by the schemes given in Figs. 2*a* and *b*.

Consideration of these schemes explains why the temperature-dependence of the intensity of the difference and sum frequencies must be different. It is well known that the anti-Stokes lines in the Raman spectrum of the first order are far more sensitive to variations of temperature than the Stokes lines. The appearance of the anti-Stokes lines involves the existence in the crystal lattice (or in the molecule) of excited vibrational states, and therefore the intensity of these lines is proportional to $\exp(-h\omega/kT)$.

For the sum of combinational lines of the Raman spectrum of the second order, the observed intensity relationships must be near those of the first-order Raman spectrum. The intensity change of the Stokes sum lines with the temperature must be comparatively small (although stronger than for the Stokes lines of the same frequency of the Raman spectrum of the first order). The anti-Stokes lines of the sum frequencies will depend strongly on the temperature (although somewhat otherwise than in the Raman spectrum of the first order).

The Stokes difference frequencies differ sharply as regards temperature-dependence from the Stokes sum frequencies of the Raman spectrum of the second order. Fig. 2*b* shows that, for the difference frequencies, the appearance even of the Stokes lines is bound up with the existence of excited states of the lattice. Therefore, for the difference frequencies, the character of the dependence on the temperature

of the Stokes lines in the scattering spectrum will be determined by an analogous factor $\exp(-h\omega_i/kT)$, which usually characterizes the temperature-dependence of the anti-Stokes lines only. Consequently, the intensity of the Stokes difference lines rises very sharply with the temperature.

The dependence on the temperature of the intensity of the anti-Stokes difference frequencies of the Raman spectrum of the second order will be somewhat stronger than that of the lines of the same frequency in the Raman spectrum of the first order.

These simple descriptive considerations are in good agreement in general with the results of theoretical calculations of the temperature-dependence of the frequencies of the second-order scattering spectra carried out for the first time by P. P. Pavinsky[1].

Thus our investigations of the scattering spectra of heated rock-salt are in good agreement with the considerations we have discussed above.

In the spectrum of scattering of heated rock-salt the strong continuous background is clearly seen, especially in the region of small frequencies (from the Rayleigh line up to 200 cm.$^{-1}$). This affords further experimental confirmation of the correctness of the fundamental concepts of the Born theory of the crystal lattice.

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May 15.

Pavinsky, P. P., unpublished paper (1945).

Crystal Structures of *para*-Dinitrobenzene and *para*-Nitraniline

In view of the rather surprising distortions reported in the dimensions of the *para*-dinitrobenzene molecule[1], a redetermination of this structure was recently attempted in this laboratory. The results of our preliminary two-dimensional survey did not point to a completely symmetrical molecule, but indicated that either (*a*) the planes of the nitro-groups may be slightly inclined (about 5°) to the plane of the benzene ring, or (*b*) the nitrogen – oxygen distances within the nitro-groups may not be equal, but differ by about 0·05 A. We were unable to distinguish between these alternatives by two-dimensional X-ray methods. In the meantime, we have learned that a full three-dimensional analysis of this structure has been undertaken elsewhere, so we have not pursued the matter further. The final results will be awaited with interest.

In the course of this work a certain resemblance was noted between the crystal structures of *para*-dinitrobenzene and *para*-nitraniline. For the former structure the space-group is $P2_1/n$, with two molecules in a unit cell of dimensions

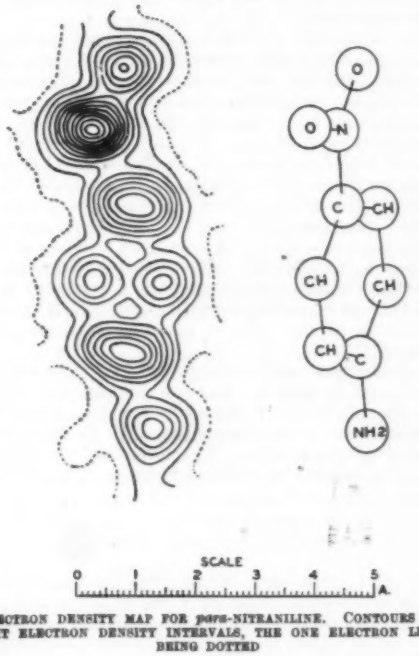
$a = 11{\cdot}05$ A., $b = 5{\cdot}47$ A., $c = 5{\cdot}67$ A., $\beta = 92°\ 18'$.

The unit cell and space-group of *para*-nitraniline have already been determined by Prasad and Merchant[2], but if the space-group description is changed to $P2_1/n$, we obtain four molecules in a cell of dimensions

$a = 12{\cdot}34$ A., $b = 6{\cdot}02$ A., $c = 8{\cdot}63$ A., $\beta = 91°\ 40'$.

The principal change is in the length of the *c*-axis, where the increase helps to accommodate the extra molecules. More detailed examination, however, shows that this apparent resemblance is somewhat misleading. In the *para*-dinitrobenzene structure there is a considerable concentration of atoms lying close to the $(10\bar{1})$ plane, whereas in *para*-nitraniline the greatest concentration is in the (101) plane. The actual inclination of the molecular plane to the (010) plane increases from 48° in *para*-dinitrobenzene to about 64° in *para*-nitraniline, although there is only a small increase in the length of the *b* axis.

The detailed structure of *para*-nitraniline has been elucidated by the method of trial and error, strong reflexions from the (800), $(50\bar{7})$ and $(70\bar{5})$ planes helping to define the molecular orientation. A refinement of the structure has been made by the double Fourier series method, and the electron density map for one molecule projected on the (010) plane is shown in the accompanying figure.



ELECTRON DENSITY MAP FOR *para*-NITRANILINE. CONTOURS AT UNIT ELECTRON DENSITY INTERVALS, THE ONE ELECTRON LINE BEING DOTTED

For this projection 110 terms in the $(h0l)$ series were employed, and it gives good resolution for some of the atoms. The remaining co-ordinates may be determined from other similar projections; but further refinement is necessary before discussing the molecular dimensions in detail.

The preliminary parameters show that the distance between the amino-nitrogen atom and the oxygen atoms of the nitro-group of the molecule reproduced by the diagonal glide plane is $2{\cdot}65 \pm 0{\cdot}05$ A. This close approach shows that hydrogen bonding between the reactive groups of adjacent molecules is the main factor in stabilizing the structure.

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July 12.

[1] James, King and Horrocks, *Proc. Roy. Soc.*, A, **153**, 225 (1935).
[2] Prasad and Merchant, *J. Ind. Chem. Soc.*, **15**, 47 (1938).

Crystal Structure of *Para*-bromochlorobenzene

THE structure of *p*-bromochlorobenzene has been investigated by Hendricks[1], who found the space-group to be $P2_1/a$, and the number of molecules in the unit cell to be two. In an exactly repeating crystal structure, this would make it necessary for the molecule itself to have a centre of symmetry, which is, of course, impossible. Hendricks suggested that the symmetry of the crystal might be statistical, the halogen positions in the molecules composing the structure being filled at random by bromine or chlorine, or perhaps the two possible orientations of any given molecule, differing by 180°, were equally probable.

It was decided to re-examine the crystal, in order to see if any evidence of faults or irregularities in the structure, which might give rise to diffuse spectra, could be found.

The compound crystallizes from acetone in thin plates, only the *a* faces being developed. The crystals are very volatile, and oscillation and Weissenberg photographs were taken with the specimen inside a gelatine capsule. The unit cell is monoclinic, with dimensions $a = 15{\cdot}2$ A., $b = 5{\cdot}86$ A., $c = 4{\cdot}11$ A., $\beta = 113°$, and contains two molecules. The space-group was found to be $P2_1/a$, in agreement with the results of Hendricks. Since the space-group has four general positions, only a statistical symmetry is possible, with a centre of symmetry at the centre of the average molecule. There was no sign of any diffuseness of the spectra, and the appearance of the photographs is consistent with a completely random occupation of the halogen positions by bromine or chlorine.

Two-dimensional Fourier projections were made on the *ab* and *ac* planes. For the first approximation, only the positions of the mean halogen atoms were assumed, and these were enough to fix the phases of most of the spectra. The fact that the benzene ring appeared in the preliminary projections indicates that the type of assumption made as to the nature of the structure is probably correct.

In the final projections, shown in Figs. 1 and 2, the atoms of the ring are clearly defined, although there is some false detail still at the centre of the ring, which probably has no particular significance, and may be due to the difficulty of allowing for the rather large absorption in the crystals, because of their flat shape. The height of the peaks in the *para* positions corresponds to a group with a scattering power the mean of that of chlorine and bromine.

The values of the atomic parameters are given in the following table:

	x	*y*	*z*
Br,Cl	0·169	0·173	0·466
C_1	0·081	0·356	0·482
C_2	0·095	0·533	0·666
C_3	0·013	0·676	0·678

They differ somewhat from those suggested by Hendricks, but are closely similar to those given by Bezzi and Croatto[2] for *p*-dibromobenzene, which has essentially the same structure. The sides of the benzene ring, which is regular, have a length of 1·41 A., and the carbon-halogen distance is $1{\cdot}77 \pm 0{\cdot}04$ A., a value nearly the mean of the C—Cl and C—Br distances, 1·69 A. and 1·88 A. respectively, found by de Laszlo[3] in electron diffraction work on the dichloro- and dibromo-compounds. It is also less than the C—Br of 1·84 A. given by Bezzi and Croatto.

In conclusion, I wish to express my thanks to Prof. R. W. James for his interest in this work, and to the South African Council for Scientific and Industrial Research, to which I am indebted for a grant.

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University of Cape Town.
June 24.

[1] Hendricks, S. B., *Z. Krist.*, **84**, 85 (1933).
[2] Bezzi and Croatto, *Gazz. Chim. Ital.*, **72**, 318 (1942); *Chem. Zentr.*, 1, 22 (1943); *Chem. Abstracts*, 3180 (1944).
[3] de Laszlo, *Proc. Roy. Soc.*, A, **146**, 690 (1934).

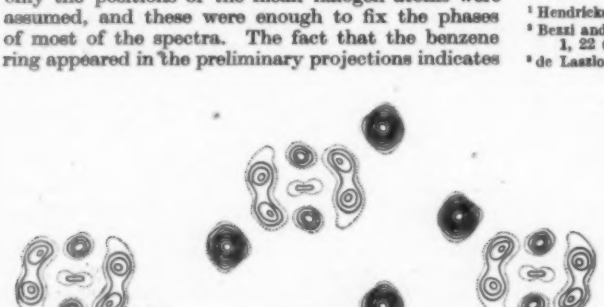

Fig. 1. PROJECTION OF ELECTRON DENSITY ON *ab* PLANE

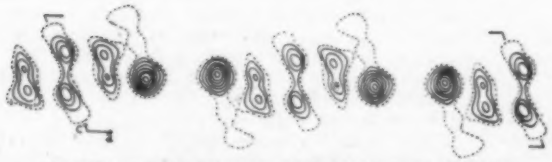

Fig. 2. PROJECTION OF ELECTRON DENSITY ON *ac* PLANE. CORNERS OF UNIT CELL ARE INDICATED

Purification of Renin by Means of Protein-Precipitating Agents

TRICHLOROACETIC acid has been used for denaturing and removing inert tissue proteins from kidney extracts containing renin[1]. It is also known that agents commonly used for removing proteins from solutions precipitate the proteins without causing denaturation in certain cases, so that the original protein may be regained. Thus trypsin and trypsinogen can be precipitated with trichloroacetic acid and the active enzymes regained[2]. In the same manner, crystalline egg albumin can be precipitated with metaphosphoric acid[3] and cathepsin by tungstic acid[4].

These investigations suggested to us the possibility of purifying renin by performing a fractional precipitation by means of such protein-precipitating agents. The blood pressure was determined by the capsular method[5].

(*A*) An extract of rabbit kidney purified by isoelectric precipitation of inactive

proteins (*p*H 4·4) was prepared. 1·42 ml. corresponded to 1 gm. kidney. It gave an increase in blood pressure of 66 mm. mercury (1 gm. kidney per kgm. rabbit was used in all experiments) and contained 6·00 mgm. N (Kjeldahl) per gram of kidney.

(*B*) To 416 ml. of *A*, 10 per cent sulphosalicylic acid was added slowly at 0° to bring the extract to *p*H 3·0. After centrifugation, 447 ml. was obtained. 1 gm. kidney ~ 1·52 ml. ~ 4·05 mgm. N ~ 68 mm. Hg.

(*C*) To 422 ml. of *B*, 7·5 ml. of 1·0 *M* sodium tungstate was added, followed by *N* hydrochloric acid to bring the extract to *p*H 2·1. The precipitate was isolated by centrifugation and dissolved in 30 ml. water with addition of sodium bicarbonate until neutral. Insoluble matter was discarded. Volume of centrifugate 38 ml. 1 gm. kidney ~ 0·137 ml. ~ 0·49 mgm. N ~ 73 mm. Hg. After dialysis, 0·30 mgm. N.

The removal of inert proteins in *B* could be carried out with trichloroacetic acid, metaphosphoric acid and tungstic acid when suitable *p*H values were used, but sulphosalicylic acid was found to give the best yields. With this treatment most of the inactive proteins were removed. The tungstic acid precipitated at *p*H 2·1 all the active substance and left in solution almost all the nitrogen-containing substances of low molecular weight. In this manner it is very easy to obtain a concentrated purified solution of renin free from the bulk of tissue proteins and from low molecular impurities, and at the same time to avoid dialysis and concentration by evaporation.

These features, together with the great variability of the conditions for precipitation of proteins by such protein-precipitating agents, as compared with the usual methods (salt precipitation, alcohol precipitation, etc.) where it is the properties of the solvent which are changed, seem to make this a very convenient method which can be adapted to the fractional precipitation of a large number of proteins. Our preliminary experience suggests that the method might be of great value in the purification of biologically active proteins and enzymes.

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Properties of the Fibrinokinase-Fibrinolysin System

IT was recently discovered that animal tissue cells contained an activator capable of transforming profibrinolysin into fibrinolysin[1]. The following properties of this enzyme system have now been found.

Two methods of investigating the action of the fibrinolysin were used. In the first method a 2–3 mm. thick layer of fibrin was prepared in a Petri dish (diameter, 10 cm.) from solutions of ox fibrinogen[2] (7 ml.), phosphate buffer (*N*/15, *p*H generally 6·5, 7 ml.) and ox thrombin[3] (50 units, obtained from Løvens kemiske Fabrik, Copenhagen). On these plates drops of the active solutions were placed. The plates were left standing 24 hours at 39°. In the second method the fibrinolysin was mixed with the fibrinogen solution before adding the thrombin, and the clot was made in a test-tube. The time in minutes for the fibrin to dissolve at 39° was measured. For the second method more potent solutions have to be used, but it permits a quantitative determination.

Fibrinokinase. The animal tissue retains its activating properties after grinding with sand and several washings with distilled water. No activator could be extracted from the tissue with the following solutions: phosphate buffer (*N*/15, *p*H 5·6–8·3), 0·9 per cent sodium chloride, acetic acid (1 per cent and 5 per cent), hydrochloric acid (0·01–0·1 *N*), ammonium hydroxide (0·01 *N*), sodium hydroxide (0·01 *N*) and glycerine (87 per cent) containing 0·5 per cent acetic acid.

The washed tissue pulp could be dehydrated with alcohol and acetone and dried with ether without destroying the activity. As a rule, a dry powder, prepared from pig's hearts, was used as activator. The tissue fibrinokinase is most stable at neutral and slightly acid reaction; at alkaline reaction it is destroyed slowly. Heating at 56° destroys it slowly, and at 70° immediately (5 min.).

The fibrinokinase activities of different tissues have been investigated, using various animal species as well as different organs. Small tissue fragments were placed on fibrin plates, and the diameter of the zone of dissolved area was used as a measure of the activity.

Tissues from calf embryo, pig and rabbit were usually found to be the most active, those from ox and rat were slightly less active, human and mouse only moderately active, while tissue from chicken and hen showed almost no activity. Of the organs, lung, heart and kidney were usually the most active. Pig's heart especially showed very high activity, while rabbit's heart was less active than other organs from rabbit. Liver and spleen were only slightly active. Stroma from erythrocytes (human) was very active.

Profibrinolysin. While the treatment (24h., 39°) of ox plasma or serum with fibrinokinase results in no activity because of a potent antifibrinolysin in the albumin fraction, the globulins prepared by 0·33 saturation with ammonium sulphate yield a very potent enzyme solution. The profibrinolysin contained in these globulin solutions is not completely precipitated by dialysis against tap water. It is rather stable against heating and changes of *p*H (stands heating to 56° for half an hour, but is slowly destroyed at 70°). Bovine profibrinolysin cannot be activated by streptokinase. Human profibrinolysin is activated by tissue fibrinokinase, but not to the same extent as with streptokinase.

Fibrinolysin. Bovine fibrinolysin is completely precipitated by dialysis against tap water, after which usually a considerable increase in activity is found. It is less stable than the profibrinolysin, being completely destroyed by heating to 70° in five minutes and slowly at 56°. It is thus possible to destroy the fibrinolysin without destruction of the profibrinolysin.

The activation may be carried out between *p*H 4 and *p*H 10 without any significant change in the activity after 24 hours incubation.

The *p*H optimum for the fibrinolysis is rather narrow, the activity being at its highest at about slightly acid reaction (*p*H 6·0–6·5).

The properties of the fibrinolysin formed seem identical with the properties of the fibrinolysin prepared by chloroform treatment.

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β-Glucuronidase and Tissue Proliferation

IN a previous communication[1] it was shown that β-glucuronidase in liver or kidney rises following administration of toxic agents to mice, depending upon the organ or organs affected. It was suggested that a rise in this enzyme is associated with tissue repair rather than the damage itself. This view is confirmed by results for kidney following administration of mercuric nitrate or chloroform to male mice. In each case, the rise in the enzyme did not occur in the early stages of poisoning, but was seen when repair was well advanced.

Age	Treatment	Interval following treatment, days	G.U.*/gm. moist tissue			Histological findings
			Spleen	Liver	Kidney	
Adult	None	—	580	280	380	—
,,	2 gm. chloroform/kgm.	1	1079	939	194	Damage and repair in liver; necrosis without evidence of repair in kidney.
		8	746	711	628	Residual damage and advanced repair in liver and kidney.
,,	20 mgm. mercuric nitrate/kgm.	1	—	436	208	Severe damage without evidence of repair in kidney; liver almost normal.
		3	715	469	808	Repair almost complete in kidney; some cell division in liver.
,,	Sub-total hepatectomy	3	—	1052	—	Very active cell division in liver.
		5	—	882	—	
		8	—	1165	—	
1 day	None	–	5100	1370	881	—
5 days	,,	–	3245	1363	793	—
13 ,,	,,	–	1521	2218	606	—
15 ,,	,,	–	5169	1239	727	—

* One G.U. (glucuronidase unit) liberates 1 μgm. phenol from 0·015 *M* phenol glucuronide at 38° and *p*H 5·2 in 1 hr.

That there is a relation between tissue proliferation and β-glucuronidase is further borne out by the fact that high enzyme contents were found in the livers of adult mice following sub-total hepatectomy, and in the liver, spleen and kidneys of baby mice. These results, which are summarized in the table, may provide a simple explanation of the finding by Fishman and Fishman[2] that administration of œstrogens to ovariectomized mice causes a rise in uterine glucuronidase, and of the high figures for tumour glucuronidase recently described by Fishman[3].

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Formation of Cellulose by *Acetobacter acetigenum*

BROWN[1] isolated from 'mother of vinegar' an organism which he designated *B. xylinum* because it formed a tough pellicle exhibiting the behaviour of cellulose. It is now known as *Acetobacter xylinum*. In more recent years, X-ray examination of the pellicle which it forms on media containing, in the several cases, glycerol and certain sugars and sugar alcohols, has shown the material to possess the same structure as vegetable cellulose (compare Hibbert and Barsha[2], Tarr and Hibbert[3], Barsha and Hibbert[4] and Khouvine[5]).

Acetobacter acetigenum, a related micro-organism, also forms a pellicle, the nature of which does not seem to have been studied. Recently, in the course of another investigation, Dr. D. Kulka working with one of us (T. K. W.) isolated a strain of *A. acetigenum* which was remarkable for the large amount of pellicle-material produced during its growth in a glucose yeast–water medium in the presence of calcium carbonate; in one experiment the dry weight of the pellicle accounted for 60 per cent of the weight of glucose initially in solution.

This strain grows well at 30° in certain natural and also synthetic media of *p*H value about 5, and it can utilize a large variety of substances as sources of energy. The pellicle from cultures on malt-wort gave the principal reactions of cellulose. Pellicles were collected from cultures grown on solutions of inorganic salts containing ammonium sulphate as the source of nitrogen, and, in the several cases, containing the following substances as the source of energy: glycol, glycerol, mannitol, arabinose, xylose, glucose, fructose, galactose, maltose, lactose, sucrose and soluble starch. The pentoses and the soluble starch afforded only slight pellicles; in the other cases the yield of material varied from 2 to 8 per cent on the carbon source. The pellicles from the pentoses and from starch were not examined in detail; chemical tests for cellulose, which were made with all the others, were positive. Further, on X-ray examination the purified pellicles gave the diagram of crystallites which is obtained on X-ray examination of cotton cellulose. When the membranes were dried under strain they showed preferred orientation. On hydrolysis with dilute sulphuric acid, the material gave glucose, characterized as the 2:4-dinitrophenylosazone, m.p. and mixed m.p. 264°. On acetolysis of pellicle matter with acetic anhydride, acetic acid

and sulphuric acid, at room temperature for 15 days, penta-acetylglucose was obtained in 25 per cent yield.

The production of cellulose from ethylene glycol by *A. acetigenum* is of particular interest in view of a suggestion of Kluyver that in certain cases glycollic aldehyde may be polymerized to sugar by bacteria; compare also the suggestion of Hibbert and Perry[6] that glycol may be the precursor of carbohydrates in Nature. Wirth and Nord[7] detected pyruvic acid in cultures of a *Fusarium* species on pentoses. They assumed the other fission product of the pentose molecule to be glycollic aldehyde, but they did not succeed in isolating the latter. During this bacterial synthesis of cellulose from glycol, it was found possible to trap glycollic aldehyde and to characterize it as the 2 : 4-dinitrophenylosazone, m.p. above 310°. The bacterial conversion of glycerol to cellulose involved the formation of dihydroxyacetone. This was characterized as the phenylosazone, m.p. and mixed m.p. 132°, and also as the 2 : 4-dinitrophenylosazone, m.p. and mixed m.p. 284°.

We are indebted to Dr. H. Lipson, who gave us facilities for the preparation of X-ray photographs.

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Detection of Acetic Acid in *A. niger* Growing on a Glucose Medium

MANY different views have been expressed concerning the chemical steps by which certain species of *Aspergillus* and of *Penicillium* convert glucose into citric acid. Some of the earlier hypotheses are now only of historical interest, and those modern views for which a reasonable amount of experimental support can be adduced have one feature in common, namely, the presumption that acetic acid is an essential intermediate. Up to the present time, however, the occurrence of this acid in cultures of *A. niger* on sugar does not appear to have been demonstrated. We have made many attempts to detect its presence in the metabolism solution, but without success, an outcome not entirely unexpected in view of the ease with which *A. niger* metabolizes acetic acid in the presence of sugar (compare Pfeffer[1]).

We succeeded, however, in demonstrating the presence of this acid in the mycelial mat of young cultures at the time when formation of citric acid had just commenced. Acetic acid was separated from the mycelium after the cells had been ruptured by grinding them with sand. Using three strains of *A. niger*, we obtained in each case only about 0·3 gm. of the acid from mycelial mats grown, in the separate experiments, on 5 litres of culture liquid. The latter consisted initially of a 12 per cent solution of glucose plus the requisite inorganic salts. A fourth strain of *A. niger* gave much higher yields, and on two occasions similar experiments afforded 2·35 gm. and 2·60 gm., respectively, of acetic acid. It was characterized as the silver salt and also as the *p*-nitrobenzyl ester, m.p. and mixed m.p. 78°.

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Utilization of Citric Acid by some So-called Citrate-non-Utilizing Bacteria

KOSER[1] showed that all types of *B. coli* are capable of growth in a simple medium in which ammonium phosphate constitutes the source of nitrogen, and a fermentable carbohydrate such as glucose or lactose is the source of carbon; when citric acid is substituted for the carbohydrates, growth occurs only with the sub-group known as *Aerobacter-Cloacæ*. Growth in such medium, called Koser's test, has since become one of the basic criteria in differentiating the Koser-negative *E. coli* from the Koser-positive members of the *Escherichia* tribe.

Certain laboratory and clinical facts led us to surmise that in presence of nitrogen compounds, other than ammonium phosphate, citric acid might be utilized even by Koser-negative organisms. In order to test this hypothesis, a typical *E. coli* and a typical *E. aerobacter* were cultured in a variety of media to all of which citric acid (30 mgm. per 100 c.c.) was added. Citric acid was estimated by a modification of the pentabromacetone method of Pucher, Sherman and Vickery[2]; and a decrease in citric acid content of the culture flasks (as compared with a sterile medium control) was taken as the index of utilization of citric acid. Cultures and controls were incubated both at room and incubator temperatures for a period varying from 1 to 4 days.

It was first found that, despite good growth, *E. coli* does not utilize appreciable amounts of citric acid in a glucose-ammonium phosphate medium (0·1 per cent ammonium phosphate with 0·2 per cent glucose); thus the presence of a readily available source of carbon does not induce *E. coli* to utilize citric acid. Moreover, it was found that in this medium *E. aerobacter*, which utilizes citric acid in the absence of glucose, does not attack citric acid until practically all the glucose has been broken down. In a basic medium of 0·1 per cent asparagine in saline (*plus* citric acid) growth of *E. coli* is not much heavier than in the glucose-ammonium phosphate medium; however, it is found that in 48 hours, 15 per cent of the citric acid has been used by *E. coli* and 94 per cent by *E. aerobacter*. Identical figures were obtained when the asparagine content was raised to 1 per cent. On the other hand, in 2 per cent peptone water (B.D.H. peptone) 94 per cent of citric acid was used up by *E. coli* but only 60 per cent by *E. aerobacter*. Under similar conditions a strain of *Staphylococcus aureus* did not utilize citric acid.

It is thus clear that the failure of *E. coli* to grow in Koser's medium does not result from a fundamental incapacity of the organism to use citric acid either as a sole or additional source of carbon, since *E. coli* has been proved to be capable of utilizing citric acid under suitable conditions. It is thought that such conditions are provided by an appropriate

hydrogen acceptor in the medium, and it is hoped to bring forward evidence in support of this hypothesis.

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* This work was carried out by N. Conway during the tenure of a McCunn Research Scholarship.

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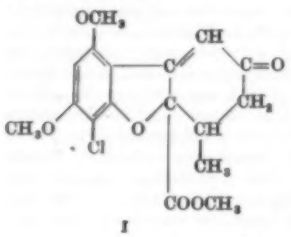
Identity of Griseofulvin and 'Curling-Factor'

When *Penicillium janczewskii* is grown in liquid culture media a substance is produced which causes stunting, excessive branching and characteristic distortions in the germ tubes of *Botrytis allii* and other fungi[1]. The substance has been isolated and called 'curling-factor'[2]. When some preliminary observations[3] were made on the chemical and physical properties of curling-factor, the presence of chlorine was overlooked and a formula $C_{20}H_{20}O_9$ was proposed. We find that chlorine is present and that curling-factor is identical with griseofulvin $C_{17}H_{17}O_6Cl$, which was isolated several years ago by Oxford, Raistrick and Simonart[4] from *Penicillium griseofulvum* (for curling-factor found: C 58·4; H 4·9 per cent; mol. wt. 362; OCH_3 23·2; Cl 9·8 (micro) and 9·7 (macro) per cent; CH_3—(C) 4·9 per cent; calculated for $C_{17}H_{17}O_6Cl$: C 57·9; H 4·9 per cent; mol. wt. 352·7; OCH_3 26·4 (for three OCH_3); Cl 10·1; CH_3—(C) 4·3 (for one CH_3) per cent). The melting point (220°) of a sample of griseofulvin which was kindly supplied to us by Prof. Raistrick was not depressed by mixing with curling-factor (m.p. also 220°); and further, griseofulvin is identical with curling-factor in its biological properties[5].

Most of the chemical reactions described by Oxford, Raistrick and Simonart have been carried out with curling-factor. A mono-oxime has been prepared; hydrolytic experiments have yielded griseofulvic acid, decarboxygriseofulvic acid and norgriseofulvic acid; and oxidation gave a chloro-hydroxy-dimethoxybenzoic acid.



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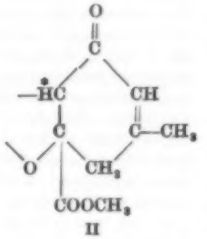

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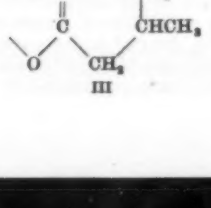

III

The formula (I) for griseofulvin was suggested[4] tentatively as a working hypothesis and accounts for most of the reactions very well. We find, however, that decarboxygriseofulvic acid forms complexes which appear to be oxonium salts, and the complexes are not formed until the carboxyl group is removed. The structure III would be expected to yield oxonium complexes and is readily derived from II by the migration of two hydrogen atoms after hydrolysis and decarboxylation. Other evidence seems to be in favour of the slight modification of part of structure I shown by II. Formula II, unlike I, readily explains the production of orcinol on alkali fusion. In II one of the centres of optical activity indicated by * should undergo fairly ready racemization through enol formation. This might explain the easy production of an isomer of griseofulvin.

All the analyses were carried out by Drs. Weiler and Strauss with the exception of the chlorine estimations, for which we are indebted to Mr. J. Haslam, of I.C.I. Plastics Division.

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A Fungistatic and Bacteriostatic Red Pigment Produced by a Strain of the *Penicillium nigricans-janczewskii* Series

Two distinct strains of the *Penicillium nigricans-janczewskii* series have been isolated from Wareham Heath soil[1]. One of these strains, regarded as typical of the species *Penicillium janczewskii* Zal., has been shown[2] to produce a substance causing marked abnormality of fungus growth; this substance has since been found to be identical with the previously known mould product griseofulvin[3]. The other strain, distinct from *P. janczewskii* and not definitely assignable to any of the described species within the *P. nigricans-janczewskii* series, has been shown to produce fungistatic and bacteriostatic culture filtrates on Raulin–Thom medium. A red pigment possessing antibacterial and fungistatic properties has now been isolated from such filtrates.

For the production of this pigment, cultures are incubated at 25° C. on shallow layers of medium for five days, when spore germination assays[4] show an activity of 16–32 B.A. units/ml. The culture filtrate is then extracted with chloroform and the extract evaporated to dryness. The residue is crystallized from ethanol, giving about 8 mgm. of crude red pigment per litre of culture filtrate.

By recrystallization from ethanol, glistening red needles are obtained. These begin to darken at 120° C. but do not melt at 380° C., nor is there any tendency for sublimation to occur at this temperature. The red pigment contains no nitrogen or halogen, and highly purified samples leave no ash on combustion. There are some indications of the presence of sulphur, but quantitative analysis has shown the amount present to be insignificant.

Microanalyses carried out by Drs. Weiler and Strauss on material three times recrystallized from ethanol and dried to constant weight *in vacuo* give results in good agreement with an empirical formula $C_5H_4O_2$ (found: C = 61·8, 62·5, 62·7; H = 4·04, 4·50, 4·34 per cent; S = nil. $C_5H_4O_2$ requires C = 62·5; H = 4·20 per cent). A methoxyl determination indicated the presence of one methoxyl group per $C_{10}H_8O_4$, and this or some multiple of this unit would seem to be the most probable molecular formula. A Kuhn–Roth oxidation gave 8·6 per cent (C)—CH_3 and a Zerewitinoff determination 0·46 per cent active hydrogen. $C_{10}H_8O_4$ requires (C)—CH_3 = 7·8 per cent (for one); active hydrogen = 0·52 per cent (for one).

The red pigment is readily soluble in hot ethanol but sparingly soluble in the cold. It is slightly soluble in cold benzene, pyridine, glacial acetic acid and 1 : 4 dioxane, giving orange solutions. The orange dilute aqueous solution which is weakly acid turns yellow when made alkaline with caustic soda, and if the solution is now re-acidified it becomes almost colourless, the latter reaction being reversible. The pigment dissolves in concentrated sulphuric acid forming a green solution, and in concentrated nitric acid forming an orange solution which is decolorized on standing. With concentrated hydrochloric acid a deep crimson solution is produced which deposits violet needles on standing. These and other reactions indicate the formation of oxonium salts.

In nutrient broth at *p*H 7·0 the red pigment prevents growth of *Staphylococcus aureus* at a concentration of 50 μgm./ml. Germination of *Botrytis allii* conidia is prevented by 0·4 μgm./ml. of red pigment at *p*H 3·5. Aqueous solutions are extremely unstable; if solutions with an initial antifungal titre of 128 B.A. units/ml. are stored at *p*H 3·5 for 24 hours at 25° C., activity falls to 16 B.A. units/ml., and at *p*H 6·5 or above to less than 1 B.A. unit/ml.

We have some evidence that the mould also produces another antibiotic substance; further chemical and biological investigations are proceeding.

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Formation of Uranium Hydride

The formation of uranium hydride (UH_3) by the action of hydrogen on massive uranium metal between the temperatures 150° and 375° C. has been described by Burke[1].

We have found in further investigations that UH_3 would form at lower temperatures. The hydrogen used was tank hydrogen purified by passage over heated copper turnings and silica gel. 10 gm. of massive uranium metal were placed in tubes which were filled with 72 c.c. hydrogen at N.T.P. The tubes were large enough to ensure the presence of sufficient hydrogen to cause complete transformation. In all cases the reaction occurred only after an apparently quiescent period, which, especially at low temperature, lasted much longer than the reaction proper.

Temperatures (°C.)	Approximate time for complete formation of UH_3
250	2 hr.
200	2 hr.
150	5 hr.
125	12 hr.
100	24 hr.
75	60 hr.
50	~1 week
20	~2 weeks

Apparently uranium and hydrogen in contact are metastable even at room temperature.

Experiments were initiated to find whether the formation of uranium hydride might provide a means of separating from irradiated metal some, at least, of those fission products which form volatile hydrides, or belong to the rare gas group.

50 gm. of massive metal were irradiated for two weeks using 5 gm. radium–beryllium in paraffin. The metal was then heated in an evacuated system to 200° C. and hydrogen was slowly passed over the metal, after which the gas went over silica gel in a liquid air trap. After the metal had been completely transformed into hydride, the hydrogen was flushed out with argon and the silica gel examined for activity. None was found.

It thus seems that not even rare gases formed in fission are released during the transformation of massive uranium into uranium hydride.

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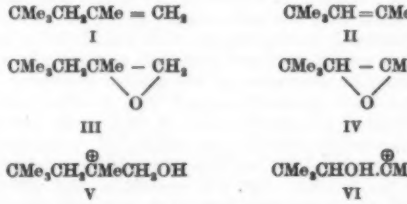
Action of Per-Acids on the Iso-Octenes

Hickinbottom[1,2] finds unsaturated alcohols are formed in the treatment with per-acids of 2 : 4 : 4 trimethyl pentene-1 (I) and -2 (II) and also in the acid hydrolysis of the epoxide (IV) derived from the latter olefin. The object of this note is to show that these results do not, as Hickinbottom claims, throw any light on the double-bond shift observed in the air oxidation of some organic compounds, but can readily be accounted for by the formation of ionic intermediates. The action of the per-acids gives initially the epoxides (III and IV) by addition of oxygen to the double bond[3].



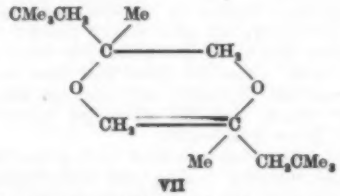
The epoxides add a proton and the oxonium complexes formed react as the ions[4], V and VI. These ions are primary and secondary alcohols respectively since the C—O bond broken is such as to form the

relatively stable isopropyl-type carbonium ion[5]. The subsequent reactions of these intermediate ions depend on the experimental conditions.

1. *Proton Loss.* V may lose a proton either from the methyl or methene group to give the two unsaturated alcohols observed by Hickinbottom, namely, $CMe_2.CH_2C(CH_2OH) = CH_2$ and $CMe_2CH = CMe.CH_2OH$. Only one unsaturated alcohol, as observed, is to be expected from VI, namely, $CMe_2.CHOH.CMe = CH_2$.

2. *Anion Addition.* Glycols result from the addition to V and VI of OH^-. In the acetic acid hydrolysis of IV, mentioned by Hickinbottom, the addition of OAc^- will give the 2 acetoxy 3-ol iso-octane.

3. *Condensation with Alcohol or Epoxide.* Ether-type compounds result from the interaction of, for example, VI with IV, yielding the neopentyl substituted 1 : 4 dioxan (VII), in general conformity with Hickinbottom's observation.



VII

Hickinbottom's work on the iso-octenes throws little light on the double-bond shift sometimes observed in the air oxidation of olefins[6]. The latter is accepted as due to the reaction of the intermediate free radical in its various resonance forms. Hickinbottom's observations, on the other hand, may be ascribed to the formation and subsequent reactions of an isopropyl-type carbonium ion.

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[1] Byers and Hickinbottom, *Nature*, **158**, 241 (1946).
[2] Hickinbottom, *Nature*, **159**, 844 (1947).
[3] Waters, "The Chemistry of Free Radicals" (Oxford University Press, 1946), p. 245.
[4] Hammett, "Physical Organic Chemistry" (McGraw-Hill Book Co., Inc., 1940), Chap. 10.
[5] Evans, A. G., *Nature*, **158**, 593 (1946).
[6] *In. al.*, Bergström, *Nature*, **156**, 717 (1945).

Dr. Bremner's suggestions for the mechanism of the formation of unsaturated alcohols from epoxides must await further experimental work to determine the real value of his deductions. In one respect, Dr. Bremner's scheme is doubtful. It might reasonably be expected that the carbonium ions V and VI would lose a proton from the oxygen more readily than from a methyl group, to form carbonyl compounds with or without an alteration in the carbon skeleton.

It has been generally agreed that the free radical hypothesis of the peroxidation of olefins can provide an explanation of the formation of unsaturated hydroperoxides. It has the very serious defect of failing to account for the epoxides and dimeric material which are also formed during autoxidation. The rearrangement of the carbon skeleton which is observed when cyclic olefins undergo autoxidation in acetic acid is a further difficulty. Indeed, the free radical, hypothesis, so far from generally being accepted, is in need of extensive revision.

The object of the suggestion put forward in my note is to provide an alternative hypothesis which, moreover, has the merit of lending itself to experimental investigation.

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Absolute Values of the Rates of Unimolecular Reactions

N. B. Slater has recently discussed this subject[1]. Some time ago, I treated the same problem[2] not in terms of the normal modes of the molecule, but of the individual bonds where the kinetic energy is expressed as a mixed quadratic form and not as a pure sum of squares. The result, then, seems to permit of an easily visualized interpretation, namely, that the rate constant depends only on the force constant of the breaking bond, the energy required to rupture it, and on the two masses of the atoms adjacent to the breaking bond. It does not depend at all on the remainder of the molecule, which simply acts as a temperature bath. Thus the result is the same as for a diatomic molecule for which the temperature-independent constant is found to be *exactly* equal to its vibrational frequency.

Quantum treatment will slightly modify this[3] in so far as, especially with light hydrogen atoms, part of their mass is to be added to the mass of the heavier atom to which they are attached. Thus in a paraffin, a C—C end bond should crack less readily than any of the inner C—C bonds, as the end carbon atoms are more heavily loaded with hydrogen.

Reverting to the classical treatment, it is interesting to note that the temperature-independent factor of the rate constant for a large molecule is in general not equal to one of its proper frequencies, but is equal to the frequency of the imaginary diatomic molecule corresponding to its fissile bond.

I have verified in the case of a linear chain of four equal atoms and equal bonds for motions only along the line joining them, that Slater's result can also be expressed in this simple manner. The conjecture that the rule stated above holds in all cases seems very probable; I have not proved it generally but verified it in many cases.

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[1] Slater, *Nature*, **159**, 264 (1947).
[2] Pelzer, *Z. Elektrochem.*, **39**, 608 (1933).

If the internal kinetic and potential energies of the molecule are

$$T' = \tfrac{1}{2}\sum_1^n \Sigma a_{rs}\dot{q}_r\dot{q}_s\ ,\quad V = \tfrac{1}{2}\sum_1^n \Sigma b_{rs}q_rq_s, \qquad (1)$$

and if the oscillations of a particular co-ordinate q_1 (which is to break if it reaches a critical length q_0) are given by

$$q_1 = \sum_1^n \alpha_s\sqrt{\varepsilon_s}\cos(\lambda_s t + \varphi_s),$$

where $\lambda_s/2\pi$ is the frequency, and ϵ_s the energy, in the sth normal mode of vibration, then it can be shown that

$$\alpha^2 \equiv \Sigma\alpha_s{}^2 = 2/b \ , \ \Sigma\alpha_s{}^2\lambda_s{}^2 = 2/a, \qquad (2)$$

where a, b denote the ratios of the determinants $|a_{rs}|$, $|b_{rs}|$ to the co-factors of a_{11}, b_{11} respectively. Thus, in my previous expression[1] for the high-pressure unimolecular rate, namely,

$$K = \nu \exp(-E_0/kT), \qquad (3)$$

where

$$\nu = \sqrt{(\Sigma\alpha_s{}^2\lambda_s{}^2)/2\pi\alpha} \ , \ E_0 = q_0{}^2/\alpha^2, \qquad (4)$$

the frequency ν and dissociation energy E_0 are, by (2),

$$\nu = \sqrt{(b/a)}/2\pi \ , \ E_0 = \tfrac{1}{2}bq_0{}^2. \qquad (5)$$

The result (3), (5) can also be obtained by a generalization of Pelzer's earlier work[2] on chain molecules.

In the particular case where co-ordinate q_1 is the extension of a bond between two atoms of masses m_1, m_2, then

$$a = m_1m_2/(m_1 + m_2) \equiv m^*, \qquad (6)$$

which is the 'reduced mass' of m_1, m_2 for relative motion along their join. If also there are no cross-terms in V between q_1 and the other co-ordinates, so that

$$2V = b_{11}q_1{}^2 + \Sigma_2^n\Sigma b_{rs}q_rq_s, \qquad (7)$$

then

$$b = b_{11}. \qquad (8)$$

Hence in this case, by (5),

$$\nu = \sqrt{(b_{11}/m^*)}/2\pi \ , \ E_0 = \tfrac{1}{2}b_{11}q_0{}^2. \qquad (9)$$

This ν is the frequency of the "imaginary diatomic molecule corresponding to its fissile bond" (atoms m_1, m_2 with potential $\frac{1}{2}b_{11}q_1{}^2$). Thus Pelzer's conjecture is true when the potential energy is of the form (7); this includes the case[2] of a chain molecule with V a pure sum of squares. A gas of these "imaginary diatomic molecules" would, of course, dissociate at the unimolecular rate (3) only if the pressure were extremely high, but this does not impair the usefulness of Pelzer's conception.

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[1] Slater, *Nature*, **159**, 264 (1947).
[2] Pelzer, *Z. Elektrochem.*, **39**, 608 (1933).

A New Source of Taraxerol

In the course of an investigation for alkaloids in *Litsea dealbata* (Lauraceæ) in this laboratory, it was noticed that from the alcoholic extract of the bark small crystals separated. Purification of these yielded a white product, m.p. 269–270° C., which gave a red-violet colour in the Liebermann–Burchardt test.

The melting point of this material and its two derivatives, the benzoyl and acetyl, together with the rotation and analysis of each, indicated that it was identical with the triterpene, taraxerol, isolated by Burrows and Simpson[1] in 1938 from the roots of *Taraxacum officinale*.

As the yield from this latter source is small and the purification from other triterpenes present tedious, little chemical work has been reported on the substance. The yield from *Litsea dealbata* being good and the purification simple, and there being, apparently, no other triterpenes present, it is intended to investigate some aspects of the chemistry of this substance.

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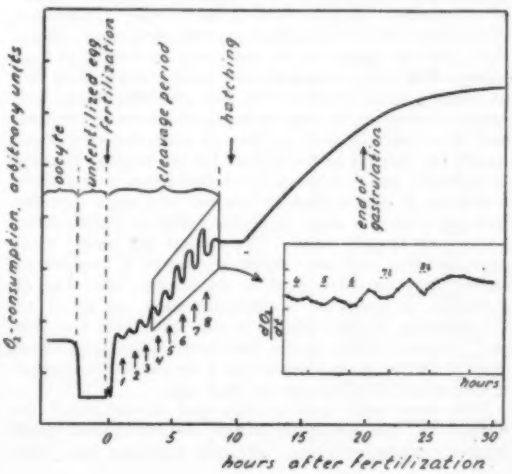
[1] Burrows, S., and Simpson, J. C. E., *J. Chem. Soc.*, 2042 (1938).

Respiration and Cell-Division in Eggs of the Sea Urchin, *Psammechinus miliaris*

As described in previous publications[1,2], we have found, by using modified Cartesian divers, that the frog's egg during cleavage respires rhythmically. The cleavage furrow invariably appears during a period of increasing respiration, the increase, however, being only slight, namely, 7–11 per cent. Single frog's eggs were used for these experiments, and the first three cleavages only were studied.

The experiments have now been continued and extended to eggs of the sea urchin, *Psammechinus miliaris*. The technique employed was a further development of that described[1], but about 200–300 eggs, dividing synchronously, were used for each experiment. The eggs were studied (at 16° C.) during the eight–nine hour period from just before the first cleavage until hatching; at least eight successive cleavages occur in this period. According to Lindahl[3], the well-known increase in respiration intensity during this period follows an S-shaped curve. I have found, however, that Lindahl's curve has waves superimposed on it, one wave accompanying each mitosis. The cleavage furrow always appeared when the respiration intensity was low. The respiratory variations accompanying the later cleavages were definitely more pronounced than those accompanying the first cleavages, the latter being of the same order as in the frog egg. According to Lindahl, hatching occurs during a period of almost constant respiration, and I have found the respiratory waves to disappear altogether just before hatching, which itself is followed by no change at all in respiration intensity.

In the accompanying figure, the inset small graph describes one experiment on about 300 sea urchin



eggs, dividing synchronously. The periods during which the cleavage furrow appears in all eggs are indicated by horizontal lines, and the cleavage numbers are given above the corresponding lines. Only cleavages 7 and 8 could not be actually observed in the microscope.

In the main figure the first part of the curve represents the respiration intensity of the oocyte and the unfertilized egg according to Lindahl and Holter[4]. As first described by Warburg[5] and afterwards confirmed by many others, an increase in respiration intensity occurs just after fertilization. The part of the curve describing this increase is based on the results of Laser and Rothschild[6], Runnström[7] and others. During subsequent development, the respiration intensity increases according to Lindahl's curve, but the mitotic rhythm described is superimposed upon the *S*-shaped part of it. It should be emphasized that after hatching the mitotic activity of the germ is most probably very much reduced.

Thus, in the sea urchin egg as well as in the frog egg, the early cell divisions appear to be accompanied by distinct respiratory variations, the biochemical significance of which, however, remains to be elucidated. In developing anthers, Erickson[8] found the respiratory intensity to vary in rhythm with the mitoses.

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[1] Zeuthen, Erik, *C.R. Lab. Carlsberg*, Sér. chim., **25**, 191 (1946).
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Rearing of *Trombicula acuscutellaris* Walch

In a previous communication[1] some successful feeding experiments with the adults of *Trombicula acuscutellaris* Walch on the eggs, ovaries and adults of *Mansonia* (*Mansonioides*) *uniformis* (Theobald) (*Tæniorhynchus* (*M.*) *uniformis*) were described. Since then, further proof of the carnivorous habits of this species has been obtained and adults have been fed on freshly killed Collembola and psocids. They are unable, however, to trap living Collembola or psocids, and it is unlikely that in Nature such active insects would be utilized as food. But for the routine feeding of nymphs and adults in the laboratory, it has been found more convenient to use culicine eggs, and for this purpose the eggs of *Culex fatigans* Wied. have been very largely used. These eggs are eaten with great avidity, and an ovipositing adult is capable of eating fifty or more eggs in 24 hours. By way of contrast, it may be mentioned that an adult of *T. deliensis* Walch, which is less than half the size of *T. acuscutellaris*, rarely eats more than two to four eggs in 24 hours and has never been known to exceed a maximum of nine eggs in that time.

The ease with which engorged larvæ could be reared to the nymphal stage in excavated glass blocks containing damp cellulose wadding has been previously recorded[2]. It has been found just as easy to rear nymphs to the adult stage on a diet of culicine eggs using the same technique. Oviposition commences within 10–12 days of the emergence of the adults. The eggs, which vary in colour from orange to reddish-orange, are invariably hidden by the female at the time of oviposition. The cellulose wadding gives them the opportunity of doing this, and it has been found that oviposition ceases if the wadding is changed to filter paper or plaster of Paris as recommended by Michener[3].

The eggs, which hatch in 10–12 days, are picked out from the wadding in the glass blocks and placed on several thicknesses of wadding in specimen tubes measuring 2 in. × ½ in. The wadding is then soaked with water up to the eighth day, after which cotton wool is wrapped around the inside of the cork. This takes up any excess moisture and prevents the larval mites from being trapped in droplets of moisture condensing in the tube.

White mice have had to be used as hosts, although they occasionally die, possibly as a result of being attacked by the mites, particularly when the numbers found attacking them are relatively large. This species is, however, not known to transmit *R. orientalis*.

The mice are placed in a wire cage the dimensions of which are 3 in. × 1 in. × 1 in., with a ¼-in. mesh. If the cage is big enough for the mouse to move its front legs freely, wadding is packed in at the rear end so as to prevent this; otherwise the actively moving larval mites are vigorously brushed off the face and ears by the mouse. The cage is placed on a platform of wire mesh resting on a wire frame ¾ in. high, which in turn is placed in a circular glass dish 6 in. in diameter and 2 in. in depth.

The tube containing the larval mites is vigorously tapped so that all the mites are shaken to the bottom. The tube is then uncorked and the mites tapped out of the tube on to the head of the mouse. A glass cover is placed over the dish. The mouse is released from the cage about 17 hours later and placed in a fresh dish. In general, only about 20 per cent of engorged larvæ are recovered from the host. The majority of unengorged larvæ, owing to their extreme motility, are found running about the dish and glass cover on the second day and are discarded. From the second day onwards, a layer of cellulose wadding is placed in the dish and damped daily with 25 c.c. of water, the glass cover being removed after the first day. Engorged mites are found trapped in the damp wadding from the third to the seventh day, the largest number of mites being obtained on the fourth day. The mouse is fed on dry bread for the first four days and thereafter on damp bread.

Larval mites of *T. acuscutellaris* generally attach themselves to the inside of the ears, particularly the meatus, around the vibrissæ and to the upper and lower eyelids. The body of the host is only occasionally chosen as a site of attack.

This species has been reared to the fourth generation using this technique. A complete account of this investigation will be published elsewhere.

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β- AND γ-RADIATION FROM U^{239} AND Np^{239}

By PROF. HILDING SLÄTIS

IN connexion with the discovery of the transuranic element $_{93}Np^{239}$, McMillan and Abelson[1] report 0·47 MeV. as the upper energy limit of the β-spectrum. The γ-radiation was found to be complex and the energy less than 0·3 MeV. Philipp, Riedhammer and Wiedemann[2,3] studied the β-spectrum of Np^{239} photographically by means of the semicircular method. They found ten internal conversion lines. Eight of them were interpreted as the *K*-, *L*- and *M*-lines of three nuclear γ-radiations of the energies 208, 226 and 276 keV., two lines as the *L*- and *M*-lines of a $K\alpha$-radiation. The results are reproduced in the accompanying table. Later, Philipp and Riedhammer[4] reported that the β-spectrum is a single one and that the β-decay is connected also with a 500 keV. γ-radiation. Recently, Feather and Krishnan[5] investigated the radiation from U^{239} by absorption measurements. They found, in the main, a single β-spectrum and give the value 1·20 MeV. for the upper energy limit. A γ-radiation of 76 keV. energy and another of at least 300 keV. were also observed.

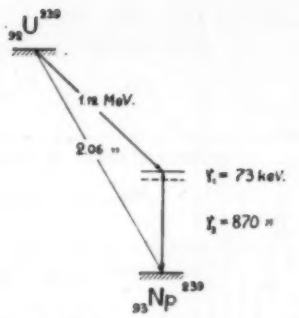

Fig. 2. NUCLEAR-LEVEL SCHEME FOR THE DISINTEGRATION OF U^{239}

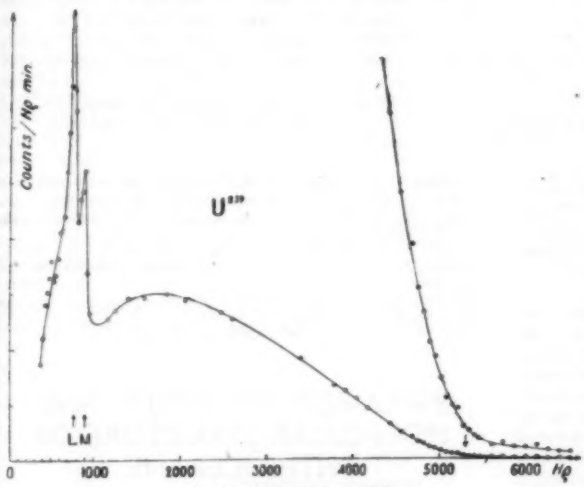

Fig. 1. β-SPECTRUM OF U^{239}

In the spring of this year I investigated the radiations from U^{239} and Np^{239}. Uranyl salicylaldehyde-*o*-phenylenediimine was irradiated with slow neutrons, and the U^{239} and Np^{239} formed were concentrated according to a technique developed by Melander[6]. Absorption measurements in lead showed that the γ-radiation from U^{239} consists of two components of energies 920 and 80 keV. Similarly, the γ-radiation from Np^{239} was found to consist of three components, 500, 200 and 51 keV.

The β-spectra were studied in a magnetic lens spectrograph constructed by K. Siegbahn[7]. The spectrum of U^{239} (Fig. 1) showed two internal conversion lines at 50·7 and 67·8 keV. They constitute *L*- and *M*-lines of a nuclear γ-radiation. The former gives the value 73·0 keV., and the latter 73·5 keV. for the energy of this γ-radiation. A Fermi analysis showed that the β-spectrum is double, with the upper energy limits 2·06 and 1·12 MeV. The difference, 0·94 MeV., corresponds to the higher value found by the absorp-

β-RAY LINES OF Np^{239}

No. of line	Notation	Philipp, Riedhammer, Wiedemann				Slätis		
		$H\rho$	$E\beta$ (keV.)	$E\gamma$ (keV.)	Remarks	$H\rho$	$E\beta$ (keV.)	$E\gamma$ (keV.)
1	L_1					631	33·9	56·8
2	L_2					671	38·2	61·1
3	L_3					724	44·2	67·1
4	M_1					766	49·2	55·1
5	M_2					818	55·7	61·6
6	M_3					861	61·4	67·3
		970	74·6	97·3	$L_{K\alpha}$ fairly weak	—	—	—
7	K_1	1050	86·2	206·2	medium	1022	84·8	206
		1090	92·4	98·3	$M_{K\alpha}$ weak	—	—	—
8	K_2	1164	105·0	225·0	strong	1152	105·8	227
9	K_3	1445	153·0	273·0		1421	154·3	275
10	L_4	1615	186·9	209·6	fairly weak	1578	185·4	208
				226·2	= L_2 } medium			227
11	L_5	1696	203·5	209·4	= M_4 }	1670	204·0	210
12	M_4	1774	221·6	227·5	weak	1760	223·0	229
13	L_6	1936	254·4	277·1	medium	1905	255·0	278
		2010	271·0	276·9	= M_5 weak	—	—	—

W = Ionization work in Pu =	Electrons			Electrons		
	K	*L*	*M*	*K*	*L*	*M*
	120	22·7	5·87	121	22·9	5·91

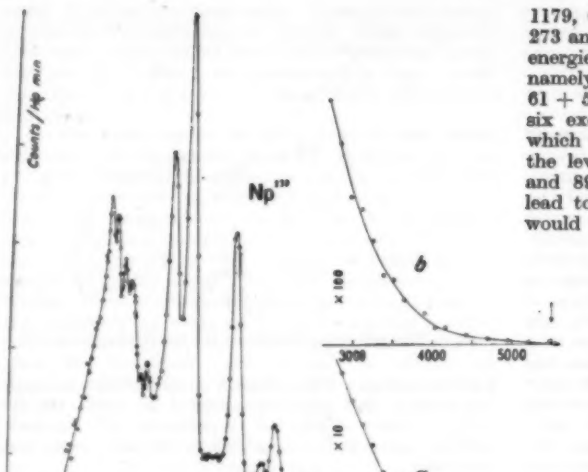

Fig. 3. β-SPECTRUM OF Np^{239}

(a) PART OF THE β-SPECTRUM, WHEN THE COUNTS ARE MULTIPLIED BY 10; (b) END OF THE β-SPECTRUM, WHEN THE COUNTS ARE MULTIPLIED BY 100

tion measurements, while the internal conversion line obviously answers to the lower one. These results lead to a disintegration scheme, in which the greatest part of the β-decay leads to an excited Np-nucleus, while a small part leads to the ground-state (Fig. 2).

In the β-spectrum of Np^{239} (Fig. 3) thirteen internal conversion lines were found. Seven of these (see table) are connected with the three nuclear γ-radiations 206, 227 and 275 keV. found by Philipp, Riedhammer and Wiedemann[3]. The six other lines are *L*- and *M*-conversion lines of three new γ-radiations of the energies 57, 61 and 67 keV. The *L*- and *M*-lines of the *Kα*-radiation in Pu^{239} were not found in the β-spectrum of Np^{239}, but appeared strongly in the spectrum of photo-electrons, released in a lead radiator. A Fermi analysis of the β-spectrum showed that it was fourfold with the upper energy limits

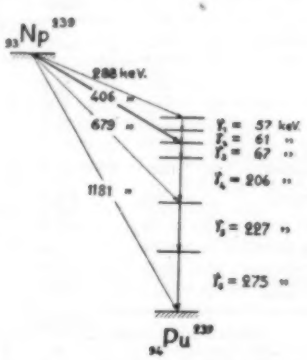

Fig. 4. NUCLEAR-LEVEL SCHEME FOR THE DISINTEGRATION OF Np^{239}

1179, 676, 403 and 288 keV. The differences, 503, 273 and 115 keV., correspond to the sum of pairs of energies computed from the internal conversion lines, namely, $503 \approx 275 + 227$, $273 = 206 + 67$, $115 \approx 61 + 57$. Therefore, the Pu^{239} nucleus seems to have six excited levels (Fig. 4), the differences between which are 275, 227, 206, 67, 61 and 57 keV. Thus the levels have the energies 275, 502, 708, 775, 836 and 893 keV. The β-decay of Np^{239} would chiefly lead to the 775 keV. level, while the other decays would lead to the levels 893, 502 keV. and the ground-state. Hence the γ-quanta would be emitted in cascade, 2, 4 and 6 in succession. An edge in the spectrum of the photo- and Compton-electrons released in lead gives evidence for a cross-over transition from the 775 keV. level to the ground-state in the Pu-nucleus.

A detailed account of these investigations will be published in the near future[8].

I wish to express my thanks to the head of the Nobel Institute for Physics, Prof. Manne Siegbahn, by whose kind offices my stay in Stockholm was made possible. I am also indebted to the Nobel Foundation for fellowship grants made to me. My thanks are equally due to Dr. Lars Melander, who has carried out the chemical preparations, and to Dr. Kai Siegbahn for valuable discussions.

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[8] Slätis, H., *Arkiv Mat., Astr. Fysik*, in the press.

INFRA-RED SPECTRUM AND MOLECULAR STRUCTURE OF PHTHIOCERANE

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AND
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THE properties of phthiocerane, the hydrocarbon derived from the wax alcohol phthiocerol[1,2] of the tubercle bacillus, for a pure specimen of which we are indebted to Prof. R. J. Anderson, Yale University, indicate a branched-chain structure[3], probably a long chain with a methyl side-chain near one end[4]. For comparison with phthiocerane, a series of hydrocarbons having a total of 34, 35 and 36 carbon atoms*, with a methyl side-chain in position 2-, 3-, 4-, or 5- from one end, have been synthesized at Uppsala, partly by the use of new synthetic methods[5]. The melting points of the synthetic hydrocarbons are plotted in Fig. 1 (the data for the *n*-hydrocarbons

* The analytical data for phthiocerol do not allow a decision between the formulæ $C_{34}H_{67}(OH)_3OCH_3$ and $C_{35}H_{69}(OH)_2OCH_3$ (cf. ref. 2). For the hydrocarbon, Stodola and Anderson favour the formula $C_{35}H_{70}$.

(1-methyl) are from Piper *et al.*[4]). The 2-methyl compounds melt at much higher temperatures than phthiocerane, and also differ in thermal behaviour and crystal structure (crystallize when pure only in tilted forms). The 3-, 4-, and 5-methyl substituted hydrocarbons, on the other hand, crystallize from acetone like phthiocerane with vertical chains, and also behave similarly on melting and solidification.

The long spacing of phthiocerane (46·3 A.) is the same as that of 4-methyltritriacontane (46·3 A.). Moreover, it is evident from Fig. 1 that the melting point of this hydrocarbon is close to that of phthiocerane. The *hk*0 reflexions observed for the synthetic hydrocarbons and phthiocerane agree closely with the corresponding strongest reflexions (that is, 110, 200, 210, 020, 310, 220) given by the vertical (*A*) form of normal chain hydrocarbons[7,8], both as regards spacings and relative intensities. The long spacing of 46·3 A. is nearly the same as that given by *n*-pentatriacontane (46·64 A., cf. ref. 8), which has two carbon atoms more in the long chain, and the main effect of the methyl side-chain in the branched-chain hydrocarbons is thus an expansion of the unit cell in the *c* direction. (The X-ray data on the synthetic hydrocarbons explain the previous interpretation of the X-ray diffraction pattern of an impure specimen of phthiocerane as being due to a normal chain[8].)

Although the data just given point to a 4-methyl substituted structure for phthiocerane, the physical properties of the hydrocarbons are such that other possibilities (mixtures) cannot be excluded on thermal and X-ray data alone (comparatively few orders of the long spacings are observed).

An infra-red investigation has therefore been carried out at Cambridge. The spectra of certain of the synthetic hydrocarbons with methyl groups in position 2-, 3-, 4- and 5- and of phthiocerane (a sample weighing about 8 mgm. was available) have been determined accurately between 700 and 1,400 cm.$^{-1}$ in solution in carbon disulphide. We find that the spectrum of phthiocerane is identical with that of 4-methyltritriacontane and 4-methyltetratriacontane, but differs markedly from those of the 2-, 3- and 5-methyl substituted compounds. The spectra are given in Fig. 2, with the exception of 2-methyltetratriacontane, which is not reproduced, since the 2-position for the methyl group is excluded on other grounds. It should be mentioned, however, that the spectrum of 2-methyltetratriacontane is quite different from any of the spectra in Fig. 2. It will be observed that the position of the methyl group has a very distinctive influence on the spectrum of these long-chain hydrocarbons, but that the spectrum is insensitive to a variation of one unit in the length of the main chain. The spectroscopic evidence for the correctness of a 4-methyl substituted structure for phthiocerane appears to be quite conclusive.

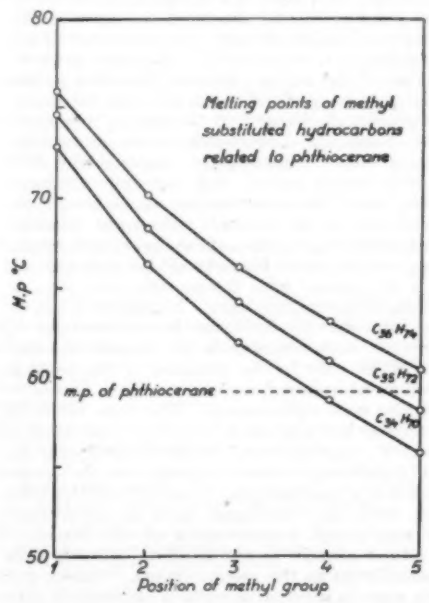

Fig. 1

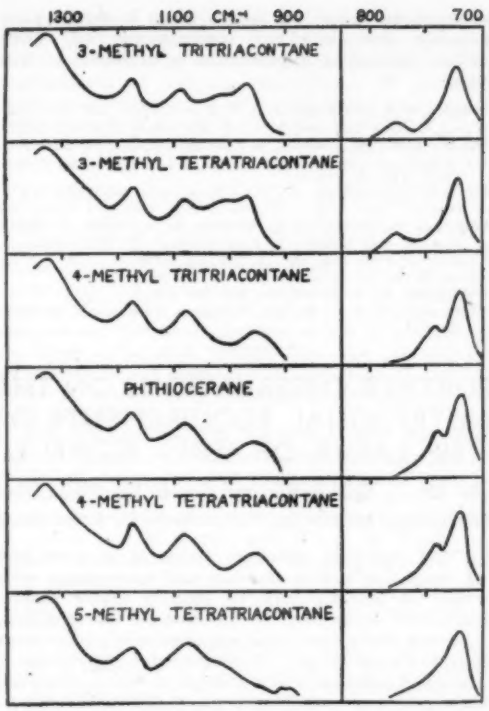

Fig. 2. INFRA-RED SPECTRA OF PHTHIOCERANE AND RELATED METHYL SUBSTITUTED HYDROCARBONS IN SOLUTION IN CARBON DISULPHIDE. 1,400–850 CM.$^{-1}$ (25 PER CENT SOLUTION); 800–700 CM.$^{-1}$ (6 PER CENT SOLUTION)

We should add, however, that apart from the empirical comparison of spectra, there is independent spectroscopic evidence that phthiocerane contains a methyl group in the 4-position. From extensive work done on hydrocarbons, at Oxford and Cambridge during the War, it is known[10] that long-chain paraffins having a methyl group in the 4-position always have a strong characteristic band at 740 cm.$^{-1}$. It will be noticed that such a band is present in phthiocerane; and the presence of this characteristic band provided strong, though not conclusive, evidence that phthiocerane has a methyl group in the 4-position. It is perhaps worth mentioning that the amount of material required for the final confirmatory run was just over 1·0 mgm. We have directed particular

attention to these last points, since it seems quite probable that infra-red spectroscopy will have further interesting applications to problems of this type.

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[4] Cf. in this connexion also Ställberg, S., and Stenhagen, E., *J. Biol. Chem.*, **143**, 171 (1942).
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FURTHER OBSERVATIONS ON THE NUTRITIONAL REQUIREMENTS OF THE LARVA OF *AEDES ÆGYPTI* L.

By Dr. L. GOLBERG and Dr. B. De MEILLON

South African Institute for Medical Research, Johannesburg

THE mosquito larva, by virtue of its short life-cycle, as well as the ease and convenience with which its growth may be studied under aseptic conditions, lends itself to biochemical investigation. A survey of its nutritional requirements is of interest from the point of view of comparative biochemistry. The brief account which follows serves to illustrate some points of resemblance which the larva bears to the chick on one hand and to lower forms on the other.

'*Folic acid.*' We have previously reported[1] that Williams's 'folic acid' preparation, supplementing a medium composed of salts, vitamins and water-extracted yeast residue, can produce complete pupation and emergence of mosquito larvæ. In such media 'folic acid' may be replaced by synthetic *L. casei* liver factor (pteroylglutamic acid)[2] or by *L. casei* fermentation factor[3]. Attempts to substitute for the yeast residue a mixture of lipoids and a pure protein revealed that 'folic acid' still had some effect; but that pteroylglutamic acid was inactive, the larvæ dying in the fourth instar. There would thus appear to be some factor or factors in the yeast residue which are necessary adjuvants of pteroylglutamic acid in larval nutrition.

Of the substances tested for their ability to supplement pteroylglutamic acid in this way, the lactone of 4-pyridoxic acid proved effective and so to a lesser extent did the lactone of 5-pyridoxic acid. In general, the results bear a striking resemblance to those of Scott, Norris and Heuser[4] in the case of the chick. Even with pteroylglutamic acid and the lactone of 4-pyridoxic acid the rate of growth, as measured by the time spent in each stage of development, was still considerably slower than in the presence of yeast residue. For this reason studies on fat and protein requirements necessitated the use of yeast autolysate as a source of 'folic acid'.

Lipoid requirements. The fact that dietary lipoid is not required by the growing larva is in keeping with the mass of observations establishing the synthesis of fats by insects from dietary carbohydrate and protein[5]. In the absence of lipoids from the diet, however, most fully grown mosquito larvæ do not pupate. Of the pupæ formed, the majority fail to emerge as adults. Thus the effect of fat in the larval diet manifests itself principally during metamorphosis, and this specialized function is correlated with the need for special types of fat. The common saturated and unsaturated fatty acids and triglycerides are quite without effect. Active compounds capable of satisfying, at any rate to a considerable extent, the particular needs of the larva for pupation and emergence, include cholesterol and related sterols, but also highly purified lecithin in which sterols could not be detected. Some degree of activity is manifested by unrelated compounds such as β-carotene and kerasin. Many other similar compounds, including some sterols, steroid hormones and phospholipides show little or no activity.

In all these cases the lipoids were 'dried' on the solid (kaolin or powdered cellulose) from a suitable solvent. However, when lecithin was tested in solution in the liquid part of the medium, the lipoid effect could not be elicited. It is to be noted, too, that the best results were obtained by using a mixture of cholesterol, lecithin and cephalin (1 : 2 : 1) in the solid state.

TABLE 1. STEROIDS CAPABLE OF BRINGING ABOUT PUPATION AND EMERGENCE OF MOSQUITO LARVÆ

Active:	*Inactive:*
cholesterol and its esters	calciferol
sitosterol	all steroid hormones and related compounds of the pregnane, androstane, and oestrane series
Weakly active:	cholesteryl chloride
ergosterol	Δ^4-cholestenone* and its enol acetate*
stigmasterol (acetate)	α-7-hydroxy- and 7-ketocholesterols
coprosterol	
Active only in presence of yeast residue factor:	$\Delta^{4,6}$-3-ketocholestadiene*
	$\Delta^{3,5}$-7-ketocholestadiene*
zymosterol	β(β),5,6(*trans*)-trihydroxycholestane
β-cholestanol	*cis*- and *trans*-Δ^5-cholestene-3,4-diols and their diacetates
cholesterol dibromide	methyl Δ^5-3-acetoxybisnorcholenate
7-dehydrocholesterol†	
Δ^5-3(β),6-dihydroxycholestene	
3(β)-hydroxy-6-ketocholestane	

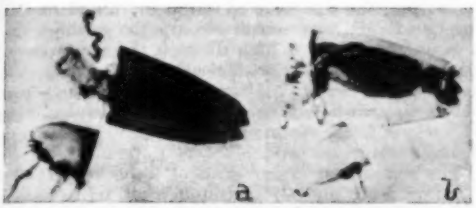
* Growth-inhibitory. † Purity uncertain.

In the case of steroids it was found that apparently inert compounds could be made effective by the inclusion in the medium of a non-lipoid factor present in yeast residue but not in yeast autolysate. In the absence of this factor even the active sterols such as cholesterol do not produce optimum growth and survival of the larvæ. Bearing this fact in mind, a study may be made of the sterol derivatives capable of replacing cholesterol in the diet of the mosquito larva (Table 1). The results are to some extent in keeping with the findings of Fraenkel and Blewett[6] on other insect larvæ, and correspond remarkably closely with the observations of Cailleau[7] on the availability of sterols for *Trichomonas columbæ*. It is of interest to note that, of the cholesterol transformation products which Haslewood[8] has listed as likely to occur in normal cells during life, only two, Δ^4-3,6-dihydroxycholestene and 3-hydroxy-6-ketocholestane, are able to fulfil the larval need for lipoid. Moreover, both compounds are capable of exercising their effect only in the presence of the yeast factor to which we referred above.

Amino-acid requirements. The time taken by the first instar larva to reach the adult stage is an elastic quantity, ranging from 7·5 days to well over 30 days and depending almost entirely on the degree of adequacy of the medium. Nowhere was this elasticity more strikingly displayed than in experiments on the amino-acid requirements of the larva. With no added protein in the medium, growth does not proceed even to the second instar. Casein, particularly when in solution as sodium caseinate (1 per cent), could be used with lipoids and yeast autolysate to

produce very good growth. Mixtures of nineteen and seventeen amino-acids were almost as effective as casein. The omission of dispensable amino-acids led to mixtures of from fourteen to eleven amino-acids, resulting in poor growth. Only a slight improvement could be brought about by varying the relative proportions of amino-acids present.

By omitting the amino-acids one at a time from the mixture of seventeen previously employed, the following were found to be indispensable for the growth of the larva: glycine, *l*-leucine, *dl*-isoleucine, *l*-histidine, *l*-arginine, *l*-lysine, *l*-tryptophane, *dl*-threonine, *dl*-phenylalanine, and *dl*-methionine. The status of *dl*-valine could not be determined while using yeast autolysate in the medium, since the autolysate was found to contain appreciable amounts of valine. 'Folic acid' could not be substituted for autolysate in amino-acid studies because no growth resulted, even when all other known growth requirements were satisfied.



SIPHON AND SADDLE OF (*a*) NORMALLY PIGMENTED FOURTH-STAGE LARVA; AND (*b*) UNPIGMENTED FOURTH-STAGE LARVA

The severity of the effect of deficiency of an essential amino-acid varied, but in the absence of each of several amino-acids no growth whatever could be observed. Perhaps the most interesting observation made in these studies was the effect of a medium deficient in phenylalanine or tyrosine. In the absence of added phenylalanine or tyrosine no growth takes place. With suboptimal amounts, the larvæ seem normal in every respect except that they appear to be wholly unpigmented. The accompanying photographs of the siphon and saddle of a normally pigmented fourth-stage larva and of the same area in an unpigmented larva serve to illustrate the ghost-like appearance of the latter. The pupæ, too, are lacking in pigment, but the adults which emerge are fully and characteristically pigmented. Two types of intermediate pigmentation were observed: in the first, black pigment begins to appear only in the fourth-instar larva; in the second, the use of substances analogous to tyrosine produced intermediate shades of pigmentation (Table 2). Both effects may be interpreted on the basis of the observation of Serra[9] that the diversity of colours of the melanins extracted from hairs of different hues results from the combination of varying proportions of melanoid pigment and protein. Lack of pigmentation does not appear to affect the rate of growth or survival.

TABLE 2. PIGMENTATION OF MOSQUITO LARVÆ IN A MEDIUM COMPOSED OF 0·5 PER CENT GELATINE, SUPPLEMENTARY AMINO-ACIDS (NO PHENYLALANINE OR TYROSINE) AND YEAST AUTOLYSATE

Compound tested	Concentration (gm. per l.)	Degree of pigmentation*
basal medium only	—	—
dl-phenylalanine	0·4	0
dl-phenylalanine	1·0	++
l-tyrosine	0·4	++
l-3-aminotyrosine	0·4	00
l-3,4-dihydroxyphenylalanine†	0·4	—
tyramine hydrochloride	0·4	0
dl-α-aminophenylacetic acid	0·4	0
p-aminophenylacetic acid	0·4	00 to +

* The significance of the symbols used is as follows:
—, white; no yellow pigment visible.
0, siphon and saddle clear yellow; no darkening.
00, siphon and saddle bright yellow; no darkening.
+, slight darkening of siphon and saddle.
++, siphon definitely darkened; saddle with a large clearly marked dark area dorsally.

† In this instance third-stage larvæ were examined. In all other cases fourth-stage pelts were used to assess the degree of pigmentation.

Despite the presence of large amounts of *dl*-methionine in the medium (up to 1·0 gm. per l.), the omission of the relatively small quantity of *l*-cystine customarily used (20 mgm. per l.) has an effect on the emergence of adult mosquitoes. The majority of the adults formed from the pupæ are found dead in the medium with only the upper half of the body projecting from the pupal case. Examination of the adults failed to reveal any obvious malformations. The same effect was occasionally observed in other amino-acid media, but was particularly prominent in the absence of added cystine. Cystine could be replaced by glutathione, but not by *dl*-homocystine.

The detailed findings, of which only the more salient features have been summarized above, will be published later, and full acknowledgment made to those who so kindly provided a number of the materials used in this work. Here we should like to thank Miss M. Currie and Mr. J. M. Thorp for technical assistance, and Mr. F. A. Brandt for the photographs.

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BACTERIOLOGY OF WATER

DIFFERENT problems involving micro-organisms in fresh water and the importance of fundamental and co-operative research in this field were considered at a symposium on water bacteriology which was held at the University of Reading on July 10, as part of the programme of the annual general meeting of the Society for Applied Bacteriology.

Dr. F. Greenshields (Metropolitan Water Board) presented a paper concerned with water-supply biology, in which he pointed out that pollution of lowland rivers in Britain in recent decades with drainage from arable land, and with sewage and trade-waste effluents, is accelerating the biological maturation of downstream reservoirs. The production of dense crops of phytoplankton, leading to excessive clogging of the filters or to the production of objectionable tastes and odours, makes it increasingly difficult to make stored water available to the consumer at certain seasons. The application of algicides to established growths is of palliative value only, and utilization of other methods of scientific control is hampered by ignorance of fundamental knowledge of growth requirements of different organisms. The increasing spread of limnological knowledge through

the medium of the Freshwater Biological Association, and the contributions of the Water Pollution Research Laboratory of the Department of Scientific and Industrial Research to the improvement in purification of sewage and trade wastes, should go far to achieve ultimate success in the effective control of algal growths.

Discussion of the paper was directed to the generally unsatisfactory procedure of chlorinating sewage effluents, which is not a feature in Great Britain, rather than endeavouring to obtain a more highly purified effluent; chlorination leaves the biochemical demand unsatisfied, and in the presence of gas works liquors may lead to production of cyanogen chloride —a substance of considerable toxicity to fish. It was considered that the construction of small-scale experimental reservoirs to follow up laboratory experiments is not so desirable as the use of reservoirs already established.

Difficulties which arise in assessing water quality from laboratory tests when coliform and pathogenic intestinal organisms develop outside their normal habitats were considered in a paper by Dr. E. Windle Taylor (Metropolitan Water Board) read by Mr. Burman. In the early days of the Second World War, it was found that efficient disinfection of water-mains after repair was sometimes difficult to achieve, and many investigations were undertaken to improve methods of repair and disinfection of mains. It was found that notwithstanding the greatest care that was taken in making a clean and hygienic repair and in the disinfection with chlorine, the raw jute yarn jointing material could itself be a source of subsequent contamination with micro-organisms. All types of coliform organisms, including *Bact. coli* type I, have been isolated, and it has been shown that some pathogenic intestinal organisms can also thrive on the yarn.

Laboratory experiments have confirmed the experience with samples collected in the distribution system that there are critical temperatures at which these coliform organisms can thrive. At the winter temperature of 4° C. and thereabouts, yarn is not a factor in the contamination of mains, but above 10° C. coliform organisms multiply actively in the yarn material. One lactose-fermenting organism having the reactions of *Bact. aerogenes*, except that it is capable of growing at 44° C., seems particularly associated with yarn and decaying wood, and on account of its frequent origin it has been christened the 'yarn' organism. Yarn in contact with water will form a breeding ground for pathogenic intestinal bacteria, and the ordinary chloramine residuals remaining in the water would have no disinfectant action. Researches have been undertaken into improving methods of chlorination of mains and into methods of sterilizing and treating joint-packing and also to find substitutes for it.

The paper led to spirited discussion on the specificity of the test involving the ability of *Bact. coli* type I to ferment lactose in MacConkey broth at 44° C., and the value of the test in view of the ability of the 'yarn' organism to carry out a similar reaction. It was suggested that if the indole test were used in conjunction with the 44° C. test it would be possible to distinguish between *coli* and *aerogenes* types growing at this temperature. In answer to a question, it was stated that jute was used as a packing material due to its cheapness and availability.

Some of the results obtained during a bacteriological survey of the Warwickshire Avon by the Water Pollution Research Laboratory in 1945–46 were given by Dr. C. L. Hannay and Irene L. Norton. In view of the fact that the bacterial flora of river water is pre-eminently Gram-negative, it was thought that interesting information might be obtained from counts in the river water of a Gram-positive organism the normal habitat of which is faecal material. Consequently a study was made of faecal streptococci isolated by means of a buffered glucose broth containing sodium azide. Results of the investigation, which included observations on the effect of sodium azide, showed that the proportion of streptococci isolated from river water which fermented mannitol was very similar to that found elsewhere for streptococci isolated from faeces. No streptococci with characteristics of either *Strep. lactis* or *Strep. bovis* were isolated, and it was considered that although the medium appeared to be specific for streptococci of Group *D*, ultimate specificity rests on serological grouping.

The paper evoked considerable discussion chiefly concerning the efficiency of the medium and method employed. It was considered by the authors that it is unlikely that at high dilution the streptococcal chains are disrupted, for replicate counts gave results in good agreement. Although no data had been obtained, it was considered that the survival-rates of various faecal streptococci and coliform bacteria in river water are probably very different.

The seriousness of infection of imperfectly sealed cans of food due to contamination with cooling water of high bacterial count was discussed by Mr. T. E. Bashford (The Metal Box Co., Ltd.) in a paper entitled "Infected Cooling Water and its Effect on the Spoilage of Canned Foods". Due to methods of manufacture, it is not always possible to have cans with perfect seals, some minute channels being left unsealed. Laboratory experiments showed that the incidence of infection of the cans is greatly affected by the numbers of bacteria in the cooling water. As many canneries are situated in rural districts where the supply of water of low bacterial count is not always available, some method of sterilization should be employed, and tests had shown that chlorination is a suitable method. Dosages of chlorine to the cooling water allowing a chlorine residual of 1–2 p.p.m. and a contact time of 20–30 min., were found effective in reducing appreciably the numbers of infected cans, but subsequent contamination during distribution of faulty cans is always possible. It was suggested during discussion that more effective sealing compounds are required, and that possibly some rubber emulsion containing an antibiotic might be satisfactory in preventing contamination of the can and spoilage of the contents.

Dr. C. B. Taylor, in a paper entitled "Some Aspects of the Bacteriology of Lakes and Streams", pointed out the paradox that water bacteriology of the text-books is largely concerned with studies of organisms which have a normal habitat other than water, and that the Freshwater Biological Association is concerned primarily with fundamental studies of bacteria capable of multiplying in the waters of streams and lakes and in the deposits beneath. Preliminary work already carried out has shown that the distribution of bacteria in lake waters, estimated by plate counts, is largely dependent on water movements, which at times are extremely complex and vary rapidly with changing atmospheric conditions. In order to obtain a properly balanced consideration of 'water bacteriology' future work must involve studies of bacteria

in (*a*) the water, (*b*) associated with the plankton, and (*c*) in the deposits. Work is in progress in connexion with the factors which limit growth of bacteria in lake waters, and it is hoped that the results will serve as an introduction to a more specialized study of the nutrition of water bacteria. As Algæ are the primary producers of organic matter in a large body of water, their association with bacteria in life and during decay is of considerable importance; present work, which has demonstrated that bacteria living on dying cells of the diatom *Asterionella* are unable to grow on common solid laboratory media, indicates the technical difficulties involved in such studies. Preliminary studies on lake muds has shown that in large bodies of water such autotrophic processes as involve nitrogen and sulphur oxidation are confined largely to the immediate surface layer of the deposits. In the discussion following the paper several speakers emphasized the need for developing work on the bacteriology of water along these lines.

C. B. TAYLOR

PRACTICAL TRAINING OF ELECTRICAL ENGINEERS

THE practical training of the professional electrical engineer is the subject of a report published recently by the Institution of Electrical Engineers*. The report, which is the work of a joint committee comprising representatives of the Institution, the Radio Industry Council and the British Electrical and Allied Manufacturers' Association, makes specific recommendations as to the character and duration of an ordered scheme of practical training, and reviews in some detail various considerations underlying its recommendations.

Where the young engineer has obtained his academic qualification by a full-time university course, the practical training should occupy two years and be termed a 'graduate apprenticeship'. Where, on the other hand, part-time technical education of appropriate standard is being pursued during the industrial apprenticeship, the duration of the practical training should be four years. This is termed a 'student apprenticeship'. Subdivision of the training period is made under three headings: basic mechanical training; basic electrical training; and office training. The first period, occupying roughly half the total time, deals with general manufacturing methods and workshop processes. It is in the second period that attention is directed towards the more specifically electrical aspects of the manufacture of particular types of electrical machinery or apparatus. The title "Office Training" is used to cover the acquisition of experience in the drawing office, planning and progress departments.

During the student apprenticeship it is assumed that the apprentice will be released from work on one day a week to attend a technical college course leading normally to a Higher National Certificate.

Stress is laid upon the value of the personal contacts which the apprentice makes with all classes of industrial personnel during his training period. It is largely through these contacts that he develops his sense of personal responsibility and his appreciation of the great importance of human relationships in industry. In the same connexion, mention is made of the merits of apprentice associations and similar bodies.

While the general plan developed in this report is based upon conditions obtaining in a relatively large manufacturing organisation, the special considerations affecting smaller firms and those specific to the operating side of the industry have also been given detailed attention. It is laid down as axiomatic that practical acquaintance with the basic processes employed in manufacture is needed by every engineer. For organisations such as electricity supply undertakings or telecommunication services, provision is therefore made for a considerable period of 'secondment' of the apprentice to a manufacturing organisation.

Quite apart from its specific recommendations, the report embodies a most careful analysis and appraisal of the duties and functions of the professional engineer and of the purposes towards which the various departments of his practical training should be directed. The report does not make specific reference to the important and difficult question of how best to integrate the military service requirement into the training period. It should be mentioned, however, that provision has been made by the Ministry of Labour and National Service for deferment to cover the whole of a five-year period of technical education and practical training. The details of this provision, which are set out in a leaflet, N.L.11, issued by the Ministry, are restated in the June issue of the *Journal of the Institution of Electrical Engineers* and are the subject of a further comment in the September issue of the *Journal*.

*The Practical Training of Professional Electrical Engineers. Report of a Committee appointed by the Council of the British Electrical and Allied Manufacturers' Association, the Radio Industry Council, and the Council of the Institution of Electrical Engineers. Pp. 42. (London: Inst. Elect. Eng., 1947.) 1s.

FORTHCOMING EVENTS

Monday, October 27

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Standardization in the Electrical Industry" (to be opened by the President, Mr. P. Good).

INSTITUTION OF THE RUBBER INDUSTRY, MANCHESTER SECTION (at the Engineers' Club, Albert Square, Manchester), at 6.15 p.m.—Mr. B. Gordon Darnton: "Incidentals in Latex Treatment".

Tuesday, October 28

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Sir Edward Salisbury, F.R.S.: "The Vegetation of the Chalk", I. "The Characteristics of the Chalk Habitat and the Chemical and Physical Factors of the Environment".

SHEFFIELD METALLURGICAL ASSOCIATION (at 198 West Street, Sheffield), at 7 p.m.—Mr. R. B. Heywood: "Photoelasticity Applied to Design Problems".

SOCIETY OF INSTRUMENT TECHNOLOGY (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 7 p.m.—Mr. J. O. V. Vick, Mr. C. Lamond and Mr. W. Lindsay: "The Organisation of an Instrument Department in an Industrial Works".

Wednesday, October 29

INSTITUTE OF WELDING (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Mr. J. L. Adam: Presidential Address.

SOCIETY OF CHEMICAL INDUSTRY, NUTRITION PANEL OF THE FOOD GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Prof. A. Haddow and Dr. L. A. Elson: "Food and Cancer".

ROYAL INSTITUTE OF CHEMISTRY, LONDON AND SOUTH-EASTERN COUNTIES SECTION (at Woolwich Polytechnic, Woolwich, London, S.E.18), at 7 p.m.—Mr. J. G. N. Gaskin: "The Examination of Questioned Documents".

Thursday, October 30

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Rev. Prof. C. E. Raven: "Early Records of British Plants with special reference to Thomas Lawson (1630–91)"; Dr. W. S. Bristowe: "Notes on the Habits and Prey of Twenty Species of British Hunting Wasps".

ROYAL COLLEGE OF SURGEONS OF ENGLAND (at Lincoln's Inn Fields, London, W.C.2), at 5 p.m.—Dr. James Craigie: "Viruses, Self-reproducing Substances and Tumours" (Imperial Cancer Research Fund Lecture).

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Dr. E. Orowan, F.R.S.: "Strength and Plasticity of Solids". (Further lectures on November 6 and 13.)

ROYAL AERONAUTICAL SOCIETY (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Mr. James Bain: Third British Commonwealth and Empire Lecture.

ROYAL STATISTICAL SOCIETY, SHEFFIELD GROUP OF THE INDUSTRIAL APPLICATIONS SECTION (in Room B 1, Department of Mechanical Engineering, The University, St. George's Square, Sheffield), at 6.30 p.m.—Mr. P. Lyle: "The Application of Regression Analysis to Industrial Problems".

ROYAL INSTITUTE OF CHEMISTRY, MANCHESTER AND DISTRICT SECTION (at the Engineers' Club, Albert Square, Manchester), at 7 p.m.—Mr. A. J. Curtin Cosbie: "Beer".

PHARMACEUTICAL SOCIETY, MANCHESTER, SALFORD AND DISTRICT BRANCH (joint meeting with the GUILD OF PUBLIC PHARMACISTS, in the Lecture Theatre, St. Mary's Hospital, Manchester), at 7.45 p.m.—Dr. R. Forgan: "British Contribution to Tropical Medicine".

Friday, October 31

BIOCHEMICAL SOCIETY (at St. Thomas's Hospital Medical School, London, S.E.1), at 2.15 p.m.—Scientific Papers.

PHYSICAL SOCIETY (in the Physics Department, Imperial College, Imperial Institute Road, London, S.W.7), at 5 p.m.—Mr. D. G. Avery and Mr. R. Witty: "Diffusion Pumps, a Critical Discussion of Existing Theories"; Mr. J. Skrebowski: "Electron Diffraction from Anthracene, with Special Reference to the Diffuse Background".

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. T. A. Kestell: Discussion on "The Manufacture of Turbine Blades for the Whittle Engine".

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at the Literary and Philosophical Society, Newcastle-upon-Tyne), at 6.15 p.m.—Dr. T. W. F. Brown: "A Marine Turbine Research and Testing Station" (Andrew Laing Lecture).

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Rt. Hon. the Earl De La Warr: "Problems Facing British Agriculture".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

RESEARCH OFFICER to take responsibility for and continuous charge of the execution of a project of research into social mobility and social class, under the direction of Mr. D. Caradog Jones—The Secretary, London School of Economics, Houghton Street, Aldwych, London, W.C.2 (October 30).

LECTURER IN BIOCHEMISTRY in University College, Dundee—The Secretary, The University, St. Andrews (October 31).

ASSISTANT IN THE DEPARTMENT OF CHEMISTRY—The Secretary, The University, Aberdeen (October 31).

TEACHERS OF (*a*) ENGINEERING DRAWING, MATHEMATICS, ENGINEERING SCIENCE, for Ordinary National Certificate and City and Guilds courses; (*b*) ENGINEERING SUBJECTS up to Higher National Certificate standard in Production Engineering; (*c*) ENGINEERING SUBJECTS up to Ordinary National Certificate standard in Electrical Engineering; (*d*) CHEMISTRY, PHYSICS, MATHEMATICS, up to Ordinary National Certificate standard in Metallurgy—The Principal, Wandsworth Technical Institute, Wandsworth High Street, London, S.W.18 (October 31).

LECTURER to teach PHYSICS to Intermediate and possibly B.Sc. standard, together with some MATHEMATICS, at the Plymouth and Devonport Technical College—The Director of Education, Cobourg Street, Plymouth (November 1).

LECTURER IN BIOCHEMISTRY—The Secretary, Royal (Dick) Veterinary College, Summerhall, Edinburgh 9 (November 1).

ASSISTANT LECTURER IN PHYSICS—The Registrar, University College of Wales, Aberystwyth (November 1).

GRADUATE LECTURER IN MATHEMATICS AND SCIENCE, either CHEMISTRY or PHYSICS—The Principal, Dudley and Staffordshire Technical College, Dudley (November 1).

TEACHER (Graduate or equivalent) OF MECHANICAL ENGINEERING SUBJECTS up to the standard of Ordinary National Certificate—The Principal, Technical Institute, Killigrew Road, Falmouth (November 1).

ASSISTANT MASTER (with a good degree in Science) to teach CHEMISTRY, with PHYSICS and MATHEMATICS as additional subjects, at the Ashington Mining School—The Director of Education, County Hall, Newcastle-upon-Tyne 1 (November 1).

TEACHERS in (*a*) MECHANICAL ENGINEERING, (*b*) PRODUCTION ENGINEERING, (*c*) GENERAL SCIENCE SUBJECTS, (*d*) AUTOMOBILE ENGINEERING, at the Chance Technical College—The Chief Education Officer, 215 High Street, Smethwick (November 1).

LECTURER IN MATHEMATICS AND SCIENCE in the Building Department—The Principal, Guildford County Technical College, Stoke Park, Guildford (November 1).

ASSISTANT LECTURER IN THE MINING DEPARTMENT of the Castleford, Whitwood, Mining and Technical College—The Divisional Education Officer, 85a Carlton Street, Castleford, Yorks (November 1).

AGRICULTURAL ECONOMISTS and ASSISTANT AGRICULTURAL ECONOMISTS in the Ministry of Agriculture and Fisheries and the Department of Agriculture for Scotland—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 2023 (November 6).

TEACHER OF BOTANY AND ZOOLOGY for day and evening classes—The Principal, Norwood Technical Institute, Knight's Hill, London, S.E.27 (November 8).

HONOURS GRADUATE IN MATHEMATICS at the South-West Essex County Technical School, Walthamstow—The Borough Education Officer, Town Hall, Forest Road, Walthamstow, London, E.17 (November 8).

AGRICULTURAL LECTURER to the Shropshire Education Committee—The Secretary for Education, County Buildings, Shrewsbury (November 8).

HORTICULTURIST in the Department of Agriculture, New Zealand Government—The Office of the High Commissioner for New Zealand, 415 Strand, London, W.C.2 (November 10).

LECTURER IN THE DEPARTMENTS OF SOCIAL STUDIES and EXTRA-MURAL STUDIES—The Registrar, The University, Leeds 2 (November 10).

LECTURER IN MORAL PHILOSOPHY in the United College, St. Andrews—The Secretary, The University, St. Andrews (November 15).

LECTURER IN PHILOSOPHY, and a LECTURER IN PHYSIOLOGY, in University College, Dundee—The Secretary, The University, St. Andrews (November 15).

STATISTICIAN in the General Register Office—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 2013 (November 15).

CHAIR OF SOCIOLOGY, and RESEARCH POSTS (2), in Natal University College, Durban—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (November 24).

ASSISTANT IN ZOOLOGY for Department of National Museums, Government of Ceylon—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.18600 (November 24).

LECTURER IN PHYSIOLOGY—The Registrar, University College of South Wales, Cathays Park, Cardiff (November 29).

MEDICAL STATISTICIAN in the General Register Office—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 2015 (November 29).

PROFESSOR OF PSYCHOLOGY AND HEAD OF THE DEPARTMENT, and a SENIOR LECTURER IN PHILOSOPHY, at the Victoria University College, Wellington, New Zealand—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (Wellington, November 30).

SENIOR PRINCIPAL SCIENTIFIC OFFICER to take charge of the Mathematical Section, a PRINCIPAL SCIENTIFIC OFFICER to conduct researches on problems associated with design of structures, SENIOR SCIENTIFIC OFFICERS (4, one for researches on reinforced concrete and the use of structural steelwork, one for mathematical research in theory of physical problems and problems of vibration and impact, one physicist or physical chemist with experience in X-ray and crystal structures work, one to initiate micro-analytical work) in the Building Research Station of the Department of Scientific and Industrial Research—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2018 (December 1).

PRINCIPAL SCIENTIFIC OFFICER for Aircraft Structural Research in the Royal Aircraft Establishment, South Farnborough—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2019 (December 1).

LECTURERS IN (*a*) CHEMISTRY to B.Sc. standard, and (*b*) PHYSICS to General Degree standard—The Clerk, Northern Polytechnic, Holloway, London, N.7.

RESEARCH CHEMIST—The Director of Research, Research Association of British Flour-Millers, Cereals Research Station, St. Albans.

SCIENTIFIC ASSISTANT (University graduate in science or agriculture)—The Director, Imperial Bureau of Animal Nutrition, Rowett Research Institute, Bucksburn, Aberdeen.

CROP RECORDERS—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

ASSISTANT II in Royal Ordnance Factories—The Appointments Officer, Ministry of Labour and National Service, 1–6 Tavistock Square, London, W.C.1, quoting K.P.105.

LECTURER IN MATHEMATICS—The Registrar, The University, Reading.

ASSISTANT III for analysis in certain Royal Ordnance Factories—The Appointments Officer, Ministry of Labour and National Service, 1–6 Tavistock Square, London, W.C.1, quoting K.P.106.

GRADUATE IN PHYSICS or ELECTRONIC ENGINEERING for designing and assembly of electrical recording devices for physiological and dust measurements—The Director, Pneumokoniosis Research Unit, Llandough Hospital, near Cardiff.

AGRONOMIST by the Directorate-General of Agriculture, Government of Iraq—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.18175.

LECTURER IN CHEMISTRY, a LECTURER IN MATHEMATICS, and a LECTURER IN PHYSICS, in the Science Department; a GRADUATE LECTURER IN MATHEMATICS, and a GRADUATE LECTURER IN MECHANICAL ENGINEERING, in the Engineering Department—The Principal, Kingston Technical College, Kingston Hall Road, Kingston-upon-Thames, Surrey.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Brompton Hospital Reports: a Collection of Papers recently published from the Hospital. Vol. 14, 1945. Pp. vii + 176. (London: Brompton Hospital, 1947.) 10*s*. [278

Proceedings of the Royal Irish Academy. Vol. 51, Section B, No. 6: Vertical Distribution of Plankton (*Sagitta*, *Calanus* and *Metridia*) off the South Coast of Ireland. By G. P. Farran. Pp. 121–136. 1*s*. 6*d*. Nos. 7, 8, 9: Antitubercular Substances. 1: Monoalkyl Succinic Acids; 2: Dialkyl Succinic Acids; 3: Monoesters and Monoamido-Derivatives of Alkyl Succinic Acids. By Vincent C. Barry and Dermot Twomey. Pp. 137–162. 2*s*. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd., 1947.) [313

East African Agricultural Research Institute, Amani. Report for the Years 1942–1945. (Colonial No. 203.) Pp. 44. (London: H.M. Stationery Office, 1946.) 1*s*. 6*d*. net. [96